Comprehensive Survey Report of the Recovery of the Fishery in Marion Millpond Following the Drawdowns from 2006-2007 and 2009-2010
(WBIC 294500)
Waupaca County, WI

Prepared by:
Jason Breeggemann – Senior Fisheries Biologist
Elliot Hoffman – Fisheries Technician Advanced
Eastern District Fisheries
Shawano, WI

2017

Executive Summary:

Marion Millpond is a 116 acre reservoir located in north central Waupaca County, Wisconsin. Marion Millpond is relatively shallow with a maximum depth of 11-12 feet and a mean depth of approximately five feet. Marion Millpond was drawn down to the original river channel from fall of 2006 through spring 2007 to reduce undesirable vegetation by desiccation and freezing and stimulate compaction of the accumulated sediment in the millpond. A second emergency drawdown took place from spring 2009 through spring 2010 to make repairs to the dam structure. This report provides a summary of the results of fyke netting and electrofishing surveys that were conducted following both drawdowns to monitor the recovery of the fishery in Marion Millpond. Also included are the results of the most recent electrofishing and fyke netting surveys that took place prior to the drawdown from 2006 – 2007 to serve as a pre-drawdown baseline from which to compare results from post-drawdown surveys to. Prior to either drawdown, Marion Millpond supported moderate densities of northern pike and largemouth with both species exhibiting good size structure and a high proportion of the individuals being sizes desired by anglers. Furthermore, the panfish population prior to either drawdown consisted of a high density of bluegills with most individuals being small and yellow perch, pumpkinseed, and black crappie occurring, but at only a fraction of the density of bluegills. Following both drawdowns, the bluegill population exploded within two years of the Millpond being drawn back up, reaching densities of over 400 bluegill per mile of electrofishing by spring of 2009 and spring 2012. Furthermore, the bluegill population has been dominated by small individuals with few bluegills > 7 inches being captured by either gear in any year. Yellow perch and pumpkinseed have also been captured in much higher densities following the drawdowns when compared to pre-drawdown surveys. Populations of these two species have also been comprised of mostly small individuals. Following both drawdowns, largemouth bass and northern pike have been found in moderate to high densities and have exhibited fast growth. Fast growth rates are likely the result of the abundant forage found in Marion Millpond. Angler exploitation is likely affecting the size structure of the northern pike and largemouth bass populations because despite fast growth rates and abundant forage, legal sized northern pike and largemouth bass make up a small percentage of the total catch of each species in most surveys. Increasing numbers of predators through additional stocking or more restrictive regulations is going to be the most effective way to reduce the densities of panfish and improve panfish growth rates and size structure. A special panfish regulation aimed at increasing angler harvest of small bluegill and pumpkinseed while protecting larger bluegill and pumpkinseed from harvest may also improve bluegill and pumpkinseed size structure. Efforts should also be made to maintain moderate densities of native plants to ensure predators can forage effectively on panfish. This will also help reduce panfish densities.

Introduction:

Marion Millpond is a small, 116 acre impoundment located in north central Waupaca County, Wisconsin. Marion Millpond is relatively shallow with a maximum depth of 11-12 feet and a mean depth of approximately five feet (Wisconsin Department of Natural Resources 2017a). As an impoundment, Marion Millpond acts as a sediment trap with approximately 50% of the substrate being silt and the other 50% sand (Wisconsin Department of Natural Resources 2017a). The primary water source for Marion Millpond is the North Branch Pigeon River, which flows into the impoundment along the western end. Additionally, a second smaller unnamed intermittent stream flows into Marion Millpond in the northwest corner of the impoundment. A dam along the eastern shoreline of the reservoir controls water levels within Marion Millpond and also marks the continuation of the North Branch Pigeon River. Two boat ramps provide fishing access to Marion Millpond; one located in Wallace Park and the other located in Lions Park. Agriculture is the primary land use (i.e., covers 47% of land use) within the watershed with forest making up the second highest percentage at 27% (Wisconsin Department of Natural Resources 2017b). Given its shallow water and nutrient inputs from a watershed with significant amounts of agriculture, Marion Millpond has a history of having dense submersed and emergent aquatic vegetation that may limit recreational use (Born et al. 1973).

Marion Millpond has a history of extensive restoration/drawdown projects aimed primarily at reducing the recreational impediments created as a result of reservoir formation and aging such as sediment deposition and reservoir filling, flooded timber, and extensive growth of emergent and submerged aquatic vegetation. The first major restoration project took place from 1969-1971. For this project, Marion Millpond was selected by the Wisconsin Department of Natural Resources (WDNR) and the University of Wisconsin as a joint project to demonstrate the effects of lake renewal and management techniques as part of the Inland Lake Demonstration Project (Born et al. 1973). During the restoration, Marion Millpond was drawn down to its original river channel, significant amounts of trees and stumps were cut and removed, sediments were removed and areas of the bottom were recontoured to increase depth in near-shore areas and remove nutrient rich sediments, and approximately 25 acres of the bottom of the millpond was covered with plastic sheeting (Born et al. 1973). This plastic sheeting was then covered with sand, gravel, or a combination of the two to create more desirable substrate for recreational uses as well as limit the growth of aquatic macrophytes (Born et al. 1973). A second restoration project took place from fall 2006 through spring 2007, again in response to accumulating sediments as well as the dense aquatic vegetation found in in Marion Millpond. During this time period, Marion millpond was drawn down to the original river channel. The purpose of this drawdown was to reduce undesirable vegetation by desiccation and freezing, flush accumulating sediments out of the reservoir downstream into the North Branch Pigeon River, and to stimulate compaction of the accumulated sediment in the millpond that did not flush downstream during the drawdown. A final drawdown lasted from spring 2009 through spring 2010. The primary purpose of this drawdown was to make repairs to the dam.

Marion Millpond has always supported and continues to support a diverse mix of cool and warm water fish species. The top predators in the millpond are largemouth bass*, Micropterus salmoides*, and northern pike, *Esox lucius*, with walleyes, *Sander vitreus*, being experimentally stocked in 1971 and 1972. Walleyes failed to develop a self-sustaining population and stocking ceased as a result. The panfish community is dominated by bluegill, *Lepomis macrochirus*, black crappie, *Pomoxis nigromaculatus*, yellow perch, *Perca flavescens*, and pumpkinseed, *Lepomis gibbosus*. Other fish species that have been observed in Marion Millpond during historical sampling include black bullhead, *Ameiurus melas*, bowfin, *Amia calva*, brown bullhead, *Ameiurus nebulosus*, common shiner, *Luxilus cornutus*, golden shiner, *Notemigonus crysoleucas*, northern hog sucker, *Hypentelium nigricans*, smallmouth bass, *Micropterus dolomieu*, warmouth, *Lepomis gulosus*, white sucker, *Catostomus commersonii*, and yellow bullhead, *Ameiurus natalis*.

As a public fishery, the Wisconsin Department of Natural Resources (WDNR) has been managing the fishery in Marion Millpond for nearly 60 years. The WDNR conducted their first recorded fisheries survey of Marion Millpond on November 2, 1959 (Primsing 1960). This survey was conducted to quantify the extent of the winterkill of 1958-1959 as well as assess the success of the northern pike and largemouth bass stocking in 1959 to recover the fishery (Primsing 1960). Only one northern pike, 15 bluegills, four yellow perch, and occasional golden shiner were captured in this survey (Primsing 1960). Fisheries surveys were also conducted in 1961, 1971, 1972, 1973, 1979, 1990, 2004, 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017. The most extensive sampling has taken place in conjunction with the major drawdowns described earlier. Fyke nets, mini fyke nets, and electrofishing have all been used to assess the fishery in Marion Millpond over time. The WDNR has only had to stock fish a few times in Marion Millpond since the late 1950s, indicating a healthy, fairly self-sustaining fishery. Largemouth bass and northern pike were stocked in 1959 as a response to a significant winterkill (Table 1; Primising 1960). Walleyes, northern pike, yellow perch, bluegill, largemouth bass, and daphnia (a zooplankton) were all stocked between 1971-1972 to help the fishery recover following the first major restoration effort that took place between 1969-1971 (Folz 1972; Born et al. 1973; Table 1). No stocking was necessary for 35 years until the major drawdown from fall 2006 through spring 2007. Significant field transfers and stockings have taken place every year between 2007 – 2016 to help the fishery recover from the two most recent drawdowns (Table 1).

Between 1973 and 2006, Marion Millpond supported a quality gamefish and panfish fishery dominated by the species described above. Given the magnitude and duration of each of the two most recent drawdowns, each drawdown likely had a significant impact on the fishery and would require intensive management for the fishery to recover following each drawdown. In an attempt to recover the fishery as quickly as possible, adult field transfers of gamefish, panfish, and prey fish species began in 2007, the year of the first draw up (Table 1). Largemouth bass have been stocked in six additional years since 2007, northern pike have been stocked in nine years since 2007, and different panfish species have been stocked on nine occasions since 2007 (Table 1). Additionally, to monitor the recovery of the fishery following the two most recent drawdowns, the WDNR has conduct electrofishing surveys every year between 2007 – 2017 and conducted fyke netting surveys in 2013 and 2017. The WDNR also conducted a fall electrofishing survey in 2004 and fyke netting survey in spring 2005 to serve as a baseline or pre – drawdown reference for the fishery. The objective of this report is to provide a summary of the recovery of the fishery in Marion Millpond following the drawdowns from fall 2006 through spring 2007 and spring 2009 through spring 2010 and compare the recovery of the fishery following these drawdowns to the baseline conditions observed in 2004 and 2005. Furthermore, the results presented in this report can be used as a guide for other fisheries biologists throughout the state for what to expect for recovery times for their fishery if they propose a similar drawdown on an impoundment with a similar fish community.

Methods:

Field Sampling – Fyke Netting:

All fyke netting surveys were conducted following WDNR spring fyke netting I (SNI) protocols as laid out in the Department's Lake Sampling Procedure Manual (Simonson et al. 2008). The objective of spring netting I surveys is to capture, measure, and mark adult walleyes for estimating their abundance. This survey can also be used to capture, measure, and mark adult northern pike. Three SNI fyke net surveys were conducted on Marion Millpond over the last 15 years; one in 2005, one in 2013, and one in 2017. The survey in 2005 was conducted prior to either drawdown and is considered a baseline for what the fishery was like pre-drawdown and can serve as a benchmark to assess recovery of the fishery following the drawdowns. The surveys in 2013 and 2017 took place following the latest drawdown and can be used to monitor the recovery of the fishery. Table two provides a summary of the sample dates, number or nets used, number of net nights, and mean water temperatures for the three fyke netting surveys. Figure 1A – 3A in the Appendix at the end of the document show the locations of all nets for each spring fyke netting survey.

Generally, spring fyke nets are set as close to ice out as possible because northern pike typically spawn shortly after ice out when water temperatures are between 35 – 40 °F (Becker 1983). Additionally, nets are set in locations that are thought to have good northern pike spawning habitat or may be travel corridors for northern pike on their way to spawning locations. Once the nets are set, each net is allowed to fish for 24 hours (i.e., one net night), meaning that all nets are checked each morning. When checking nets, all fish are removed from each net and placed in a livewell. All gamefish (i.e., walleye, northern pike, and largemouth bass) are measured for length, weighed, sexed if possible, examined for a small fin clip (i.e., partial top caudal/tail fin clip or another fin clip given at the time of stocking), given a small top caudal fin clip if one is not observed, and released at a location away from the net so that they do not swim right back into the net. All panfish are measured for length and released. If a significant amount of panfish are captured throughout the survey, a subsample of each species may be measured for length. All panfish not measured are counted. Additionally, otoliths were collected from 5 – 10 bluegill in all half inch length bins from the 2013 netting survey and otoliths were collected from 5 – 10 bluegill in two specified length categories (i.e., 5.5 – 6.4 inches and 6.5 – 7.4 inches) from the 2017 netting survey for age and growth analysis. All other species are counted and released at a location away from the net so they do not swim right back into the net again. After all the fish are removed, the net is set back in place and allowed to fish for approximately 24 hours until it is checked the next day. If a net is not catching many fish, it may be relocated to a different spot and set up again, or it may be removed from sampling (Simonson et al. 2008).

Field Sampling – Electrofishing:

All electrofishing surveys were conducted following WDNR fall or spring electrofishing protocols as laid out in the Department's Lake Sampling Procedure Manual (Simonson et al. 2008). The objective of fall electrofishing surveys is to capture and measure young of year of all species but can also be used to sample adults of all species as well. The objective of spring electrofishing surveys is to capture and measure adult largemouth and smallmouth bass as well as panfish. Thirteen electrofishing surveys have been conducted on Marion Millpond over the past 15 years. The earliest survey, conducted in fall 2004, took place before either of the drawdowns and is considered a baseline for what the fishery was like pre-drawdown and can serve as a benchmark to assess recovery of the fishery following the drawdowns. Electrofishing surveys were conducted following both drawdowns during fall 2007, 2008, and 2010 and spring 2008, 2009, and every spring 2011 and 2017. All surveys were conducted using pulsed direct current (DC) electrical settings and survey crews consisted of one boat driver and two experienced dip netters collecting fish on the bow of the boat. All electrofishing surveys were conducted after dark when fish move into shallower water and are more susceptible to sampling gears. Table three provides a summary of the electrofishing surveys conducted in each year including the date electrofishing occurred, the total miles shocked, miles shocked where only gamefish were collected, miles shocked where all fish were collected, mean water temperature, and electrofishing boat settings including volts, amps, pulse rate, and duty cycle. Maps of electrofishing station locations can be found in Figure 4A – 16A in the Appendix at the end of the document.

Two different station types are used during electrofishing surveys: 1.) a gamefish station in which only largemouth bass, northern pike, walleye, and muskellunge are netted and placed in a livewell for collection of scientific data; and 2.) a panfish/dip all station in which all fish that are encountered are netted and placed in a livewell for collection of scientific data (Simonson et al. 2008). Following completion of an individual station, all netted fish are identified, counted, and all gamefish and panfish are measured for total length. Gamefish are also examined for a fin clip indicating a recapture from a previous DNR survey or stocked origin. If a significant amount of panfish were netted during a single panfish/dip all station, three random scoops of panfish were collected from the livewell and all individuals captured in those three scoops were measured. The rest of the panfish that were captured during the station were identified and counted (Simonson et al. 2008).

Data Analysis:

Despite the fact that fyke netting surveys are most effective at sampling northern pike and that electrofishing surveys were most effective at sampling largemouth bass and panfish, metrics were calculated for all gamefish and panfish from both netting and electrofishing surveys to provide the most comprehensive information possible regarding the recovery of the fishery following the drawdowns. The total number of all species captured as well as mean, min, and max lengths for gamefish and panfish species, catch per unit effort (CPUE), proportional stock density (PSD), and length frequency histograms were created for northern pike, largemouth bass, bluegill, pumpkinseed, black crappie, and yellow perch for all sampling. Trends in all of these metrics were used to assess the recovery of the fishery following the two drawdowns by comparing metrics calculated from post-drawdown surveys to those from pre-drawdown surveys. Furthermore, metrics from recent surveys were compared to other lakes throughout Wisconsin to gauge how the fish community in Marion Millpond compares to other fisheries statewide.

Catch per unit effort (CPUE) refers to the number of a given species captured per unit distance or time. For netting surveys, CPUE is quantified as the number of a given species captured per net night, or 24-hour net soaking period. For electrofishing surveys, CPUE is typically quantified as the number of a given species captured per mile of shoreline. Proportional stock density (PSD) is an index used to describe the size structure of a given species. It is calculated by dividing the number of quality size and larger individuals captured by the number of stock size and larger individuals captured. Quality and stock lengths for all species were taken from Anderson and Neumann (1996). Proportion stock density values of 40 – 60 typically describe a balanced fishery, meaning a population contains both harvestable size fish as well as smaller fish that will grow to harvestable size in the next couple of years (Swingle 1950).

Length frequency histograms are a graphical representation of the number or percentage of fish of a given species captured by size intervals. Given that effort (i.e., number of net nights or miles of shoreline shocked) varied among sampling events, percentages will be used so as not to unintentionally show what appears to be differences in catch rates or density. One inch size intervals were used for largemouth bass and northern pike, whereas half inch size intervals were used for bluegill, pumpkinseed, black crappie, and yellow perch. A Schnabel population estimate using multiple mark and recapture events was used to estimate northern pike population size. Number of marked and unmarked northern pike from each days fyke netting surveys were used to get an estimate of the total number of northern pike in Marion Millpond during each survey year. Otoliths collected from bluegill in 2013 and 2017 were embedded in an epoxy resin and a thin section was taken out of the center of each otolith. Two readers estimated the age of each bluegill. Mean age of bluegills captured in each of the two length bins was calculated and compared to other statewide data to evaluate the growth rates of bluegill in Marion Millpond.

Results:

Prior to the two drawdowns in 2006 – 2007 and 2009 – 2010, Marion Millpond supported a high quality, healthy fishery with many of the species present meeting department management objectives. Species captured during the electrofishing survey in 2004 and netting survey in 2005, prior to either drawdown include black bullhead, black crappie, bluegill, brown bullhead, golden shiner, largemouth bass, northern pike, pumpkinseed, warmouth, white sucker, yellow bullhead, and yellow perch (Table 4; Table 5). Marion Millpond showed significant resilience to the two drawdowns and the major disturbances they created as most species captured prior to drawdowns were captured in the first fyke netting and electrofishing surveys following the drawdowns (Table 4; Table 5). The following paragraphs present trends in the recovery of individual gamefish and panfish species in relation to their abundance and size structure prior to either of the drawdowns. Results from netting surveys and electrofishing surveys are presented separately because the effectiveness of each of these gears at capturing each species can be highly variable. For example, fyke nets are much more effective than electrofishing at capturing northern pike because northern pike use their burst swimming speed to easily swim away from the electrical field of a shocking boat when they first sense the electricity. Therefore, electrofishing is not the best gear to sample northern pike.

Fyke Netting:

Largemouth Bass:

Given that electrofishing is the preferred method to sample largemouth bass, few conclusions regarding largemouth bass will be drawn from the results of the three fyke netting surveys. Similar to northern pike, largemouth bass have been shown to readily grow to sizes desired by anglers in Marion Millpond. Mean lengths of largemouth bass captured in the three fyke net surveys were 13.3, 13.8, and 17.3 in 2005, 2013, and 2017 respectively (Table 4). Additionally, largemouth bass showed fast growth following the drawdown between 2009 – 2010 as largemouth bass from every inch class between 8 and 16 inches were captured in 2013, just three years after Marion Millpond was drawn back up (Figure 2). Given that most largemouth bass were likely flushed downstream during the drawdown, the largemouth bass that were 12-16 inches were likely only four years old or less, with some being the yearlings that were stocked in spring, 2010. Reaching legal harvestable size by age-4 is very fast growth for largemouth bass in the state of Wisconsin.

Northern Pike:

Prior to both the drawdowns, northern pike densities in Marion Millpond were found at 2.4 northern pike per net night in 2005 (Figure 1). Surprisingly, in spring 2013, just three years after Marion Millpond was filled following the last drawdown, 8.1 northern pike per net night were caught in the spring fyke netting survey, a density that was over three times higher than what was observed in the 2005 pre-drawdown survey (Figure 1). By spring 2017, northern pike densities had increased even higher, to 9.3 northern pike per net night (Figure 1). A density of 9.3 northern pike per net night is considered a high density for the state of Wisconsin, falling into the 92nd percentile when compared to statewide spring fyke netting surveys. This means that the northern pike density in Marion Millpond in 2017 was higher than 92% of the other lakes throughout the state of Wisconsin. Unfortunately, catches of northern pike in 2005 and 2013 did not allow for accurate population estimates for this species (Table 6). Too few total northern pike were captured in 2005 and too few northern pike were recaptured in 2013 (Table 6). Because of this, confidence intervals were very wide in 2005 and 2013, meaning an accurate population estimate could not be calculated (Table 6). Northern pike were estimated to have a population of 728 pike in 2017, with a 95% confidence interval range of 540 – 1,118 northern pike within Marion Millpond. The equates to approximately 6.3 northern pike per acre, which is also a moderate-high density when compared to other population estimates of northern pike throughout the state of Wisconsin.

Survey results have shown that Marion Millpond has consistently produced pike of the sizes that are desired by anglers. The mean length of all northern pike captured in the 2005 fyke net survey was 23.7 inches, with a range from 15.9-33.0 inches and a PSD of 70 (Table 4; Figure 2). Furthermore, northern pike as small as 15.9 inches were captured in 2005, and northern pike in every inch class between 15 and 31 inches were captured during that year’s fyke net survey (Figure 3). These results indicate a northern pike fishery with consistent recruitment and the ability to grow to sizes >30 inches existed prior to the drawdowns. By spring 2013, just three years after Marion Millpond was refilled after the last drawdown, the size structure of northern pike was nearly the same as it was prior to the drawdowns. The mean length of northern pike sampled in fyke nets in 2013 was 23.9 inches with a range of 13.6 – 33.2 inches, and a PSD of 87 (Table 4; Figure 2). Similar to 2005, northern pike in every inch class between 15-31 inches were also captured in 2013. Given that most of the northern pike were likely flushed downstream during the drawdown between 2009 – 2010, the fact that the mean length of northern pike just three years after the impoundment was refilled was 23.9 inches and the vast majority of the northern pike captured were >21 inches, likely indicates very fast growth. However, no calcified structures were collected to verify ages. By 2017, northern pike size structure had declined slightly, compared to the previous two fyke net surveys. Northern pike mean length in 2017 was 20.9 inches with a range of 10.8 – 29.3 inches, and a PSD of 58 (Table 4; Figure 2). Northern pike in every inch class between 10 – 29 inches were captured, indicating plenty of pike that are sizes preferred by anglers with plenty of smaller pike that will grow to harvestable size in the next couple of years (Figure 3).

Bluegill:

Prior to the two drawdowns, Marion Millpond supported a moderate to high density bluegill fishery, averaging 42.7 bluegill per net night in the 2005 fyke net survey (Figure 1). By 2013, just three years after the latest drawdown, bluegill densities were extremely high, averaging 144.6 bluegills per net night (Figure 1). BY 2017, bluegill relative abundance had decreased to levels much closer to what was observed prior to the drawdown, averaging 31.2 bluegill per net night. Despite the significant decline in density between 2013 and 2017, a bluegill relative abundance of 31.2 bluegill per net night still ranks out in the 75th percentile for bluegill densities in spring netting surveys throughout the state of Wisconsin. The trend of supporting a high-density bluegill fishery has continued in most years following the drawdowns.

Prior to the drawdowns, bluegill size structure was moderate in Marion Millpond. Mean length of all bluegill captured in the 2005 fyke net survey was 5.7 inches, with a range of 3.9 – 7.7 inches, and a PSD of 43 (Table 4; Figure 2). In 2005, bluegill in every half inch length bin between 3.5 and 7.5 inches were captured (Figure 3). However, only 10% of the bluegill captured in 2005 were $\geq$ 7 inches and no bluegill $\geq$ 8 inches were captured (Table 4; Figure 3). Bluegill size structure in 2013 was similar to what was observed in 2005, with bluegill having a mean length of 5.9 inches, a range of 4.5 – 8.5 inches, and a PSD of 36 (Table 4; Figure 2). The slight decrease in PSD can be attributed to the prevalence of a couple of strong, younger year classes. Additionally, bluegill were captured in every half inch length bin between 4.5 and 8.5 inches in 2013, but only 2.8% of the bluegill captured were ≥ 7 inches (Figure 3). Bluegill size structure remained fairly constant between 2013 and 2017, with the mean length of bluegills captured in 2017 being 6.0 inches, with a range of 3.5 – 8.3, and a PSD of 54 (Table 4; Figure 2). In 2017, bluegill were captured in every half inch length bin between 3.5 and 8.0 inches, but only 6.2% of bluegill captured were ≥7 inches.

Bluegill growth was fast immediately following the drawdowns. Most of the bluegill that were captured in the spring 2013 fyke net survey were estimated to be three years old, from the 2010 year class. The mean length of age-3 bluegill in Marion Millpond in 2013 was 5.8 inches. Abundant resources and little competition immediately following the drawdown likely resulted in the fast growth rates. Two other age classes of bluegill were observed in 2013, six year olds and eight year olds. The six and eight year olds were likely from the adult stockings that took place in 2010 following the latest draw down, although some could have survived in the river during the drawdown. After several successive strong year classes and increases in density, growth of bluegill in Marion Millpond slowed. Otoliths taken from bluegill between 5.5 – 6.4 inches, and 6.5 – 7.4 inches collected from the 2017 fyke net survey showed that these two size groups average being 5.3 and 5.5 years old respectively (Table 7). These results show that bluegill growth in Marion Millpond is now slow – moderate.

Pumpkinseed:

Within the three fyke net surveys, pumpkinseed relative abundance was the lowest in 2005, when only 2.2 pumpkinseed per net night were captured (Figure 1). Despite the two drawdowns, pumpkinseed densities had more than doubled by 2013, when 5.4 pumpkinseed per net night were captured (Figure 1). The upward trend in pumpkinseed densities continued through 2017 when 9.3 pumpkinseed per net night were captured (Figure 1). Pumpkinseed densities in Marion Millpond in 2017 (i.e., 9.3 per net night) were high for the state of Wisconsin, ranking out at the 86th percentile when compared to other spring netting surveys throughout the state of Wisconsin.

As pumpkinseed densities increased through time, pumpkinseed size structure has decreased. In 2005, prior to either drawdown, the mean length of pumpkinseed captured in the fyke netting survey was 5.8 inches, with a range of 3.5 – 8.0 inches, and a PSD of 39 (Table 4; Figure 2). In 2005, pumpkinseed were captured in every half in length bin between 3.5 and 8.0 inches (Figure 3). In 2013, the year of the first fyke netting survey following the drawdowns, the mean length of pumpkinseed was 5.6 inches, similar to what was observed in 2005, with a range of 4.9 – 6.2 inches (Table 4). However, pumpkinseed PSD in 2013 had dropped to 13 (Figure 2), and only 13% of the bluegill captured were $\geq$6 inches (Figure 3). The small size structure observed in 2013 could be a result of the short time between the latest drawdown and the survey. By 2017, when pumpkinseed densities were the highest, size structure had decreased to the lowest observed for any of the fyke netting surveys. Mean length of pumpkinseed had decreased to 4.9 inches, with a range of 3.6 – 7.9, and a PSD of only 7 (Table 4; Figure 2). In 2017, pumpkinseed were captured in every half inch length class between 3.5 and 6.5 inches with a couple of pumpkinseed in the 7.5 inch class also captured (Figure 3). However, only 6.8% of all pumpkinseed captured in 2017 were ≥ 6 inches.

Black Crappie:

Results from fyke net surveys have shown that in most years, black crappie densities in Marion Millpond are low. The density of black crappies in 2005, prior to the drawdowns, was just 1.7 black crappie per net night (Figure 1). Black crappie densities in the two fyke net surveys following the drawdown were even lower at 0.5 black crappies per net night in 2013 and 0.2 black crappies per net night in 2017. A black crappie density of 0.2 black crappies per net night (i.e., the density observed in 2017) ranks out at the 10th percentile statewide when compared to other spring fyke netting surveys conducted throughout the state of Wisconsin. This means that black crappie densities in 2017 were only higher than 10% of the other lakes throughout the state of Wisconsin.

Black crappie size structure has varied throughout the three fyke net surveys. In 2005, the mean length of black crappies captured was 8.7 inches, with a range of 4.8 – 14.0 inches, and a PSD of 78 (Table 4; Figure 2). The black crappie population in 2005 appeared to be dominated by two strong year classes of crappies that were between 7.5 and 11 inches long as 90% of the crappies captured in 2015 were within these length bins (Figure 3). In 2013, the mean length of black crappies captured had decreased to 6.9 inches, with a range of 4.8 – 10.9 inches and a PSD of 27 (Table 4; Figure 2). Furthermore, the black crappie population in 2013 was dominated by smaller individuals with 75% of the black crappies captured being < 6.5 inches (Figure 3). The black crappie population in 2017 was a more even mix of individuals of all sizes, with a mean length of 8.1 inches, with a range of 5.6 – 11.9 inches, and a PSD of 57 (Table 4; Figure 2). Results from the 2017 fyke net survey showed that no strong year classes of black crappies were present in Marion Millpond as the few individuals that were captured were spread out among a wide range of lengths (Figure 3).

Yellow Perch:

Marion Millpond has supported healthy numbers of yellow perch over the last 15 years. In 2005, the density of yellow perch was 7.4 yellow perch per net night (Figure 1). By 2013, just three years after Marion Millpond was drawn up following the latest drawdown, yellow perch densities had exploded to 123.3 yellow perch per net night (Figure 1). By 2017, the density of yellow perch had declined down to only 27.1 yellow perch per net night (Figure 1). However, despite the significant declines in yellow perch density between 2013 and 2017, a density of 27.1 yellow perch per net night (i.e., the observed density in 2017) still ranks out in the 87th percentile when compared to other spring fyke netting surveys conducted throughout the state of Wisconsin. Therefore, Marion Millpond still supports a very high density yellow perch population. The size structure of the yellow perch population in the three fyke netting surveys in 2005, 2013, and 2017 was nearly identical, and very poor. The mean length of yellow perch captured in all three years average between 6.2 – 6.3 inches, had a minimum length of approximately 5 inches and a maximum length of 9.5 – 10.3 inches in each year and had a PSD of < 5 in each year (Table 4; Figure 2). Size distributions of yellow perch in all three years showed that the highest number of yellow perch were between 5.5 – 6.0 inches with numbers of larger yellow perch declining sharply in all three surveys (Figure 3).

Electrofishing:

Largemouth Bass:

Prior to both the drawdowns, Marion Millpond supported a high quality largemouth bass fishery. Largemouth bass densities in fall 2004 were at approximately 28.3 largemouth bass per mile of electrofishing (Figure 4). In every electrofishing survey evaluating the recovery of the largemouth bass population following the first drawdown (i.e., fall 2007 through spring 2009), largemouth bass densities were higher than what was observed before the drawdown (Figure 4). Largemouth bass densities ranged from 33.0 largemouth bass per mile up to 201.0 largemouth bass per mile during these four surveys. Densities of largemouth bass in Marion Millpond in every electrofishing survey following the second drawdown were just as high as densities observed in the pre-drawdown survey of 2004, except the spring 2016 survey (Figure 1). Largemouth bass densities between 2010 and 2017 ranged from 19.0 – 86.0 largemouth bass per mile of electrofishing (Figure 1). Results from the spring 2017 electrofishing survey have shown that largemouth bass densities in Marion Millpond are currently at 40.0 largemouth bass per mile. This is a fairly high density of largemouth bass, ranking out in the 81st percentile for spring electrofishing surveys throughout the state of Wisconsin. Intense stocking of yearling and large fingerling largemouth bass that has taken place in most years following each drawdown is likely why densities were high immediately following each drawdown.

During fall 2004, the mean length of largemouth bass in Marion Millpond was 12.4 inches, with a range of 5.0 – 18.4 inches, and a PSD of 63 (Table 5; Figure 5). Furthermore, largemouth bass were captured in every inch class between 5 – 18 inches in 2004 (Figure 6). Prior to the two drawdowns, Marion Millpond had a balanced largemouth bass fishery with decent numbers of harvestable size individuals as well as some smaller individuals that would grow to be harvestable size in the next couple of years. During the first couple of years following each of the drawdowns, the largemouth bass population was dominated by smaller individuals. The mean length of largemouth bass sampled in 2007 and 2008 ranged from 4.5 – 6.2 and the mean length of largemouth bass sampled in 2010 and 2011 ranged from 6.9 – 7.3 (Table 5). By spring 2013, within three years following the second drawdown, the largemouth bass population consisted of a fairly even mixture of size classes with largemouth bass in every inch class between 5 – 17 inches being captured.

Following each of the drawdowns, largemouth bass grew very quickly in Marion Millpond. For example, the majority of the largemouth bass captured in the spring 2008 survey were between 3 – 8 inches long, likely one or two years old (Figure 6). By spring 2009, just one year later, this large group appears to have grown to 7 – 12 inches, growing about four inches in a year (Figure 6). Growth was equally fast following the second drawdown. The majority of the largemouth bass captured in the spring 2011 electrofishing surveys were between 5 – 8 inches, and were likely one or two years old. This strong year class grew to 9 – 12 inches by spring 2012 and 13 -15 inches by spring 2013, meaning they were growing approximately 3 – 4 inches per year (Figure 6). Furthermore, they were reaching harvestable size by age 3 – 4. This is particularly fast growth given the mean age of a 14 inch largemouth bass throughout the state of Wisconsin is approximately 6 years old. The yearling largemouth bass stocked in spring 2010 were given a right ventral (RV) fin clip, and recaptures of fin clipped fish from this stocking can also be used to assess growth. A 10.43 inch RV clipped largemouth bass was captured in the fall 2010 electrofishing survey, meaning this fish reached 10.43 inches in just 2 growing seasons.

Furthermore, five RV clipped largemouth bass were captured in the spring 2012 survey, when these bass would have been three years old. The mean length of these five RV fin clipped largemouth bass was 14.4 inches (range = 13.8 – 15.1 inches), meaning some were reaching harvestable size in three years. Seven RV clipped largemouth bass averaging 15.8 inches (range = 15.0 – 16.9 inches) were captured in spring 2013, when they were just four years old. Results from electrofishing surveys have also shown that largemouth bass recruitment can be variable in Marion Millpond. Very few small largemouth bass were captured in spring 2015 and spring 2016 surveys, and PSD values in both these years were near 100 (Figure 5; Figure 6). Sampling in 2017 showed a more even mixture of size classes, but the length frequency histogram still showed some gaps in size classes present (Figure 5; Figure 6).

Northern Pike:

Given that fyke netting is the preferred method to sample northern pike, few conclusions regarding northern pike will be drawn from the results of the electrofishing surveys. Trends in northern pike CPUE from electrofishing surveys followed similar trends to those observed during netting surveys. Northern pike densities in the 2013 electrofishing survey were nearly double the observed density in 2004 electrofishing survey (Figure 4). The overall trend in northern pike densities from electrofishing surveys was upward between 2013 and 2017, which was the same trend observed in the netting surveys (Figure 4). Results from electrofishing surveys have also shown that northern pike can grow quickly and reach desirable sizes in Marion Millpond. Northern pike PSDs were in the 40 – 60 range in most years indicating at least 40-60% of the northern pike sampled were >21 inches (Figure 5). Additionally, by the spring of 2013, just three years after Marion Millpond was drawn up, six of the seven northern pike captured were between 19 – 27 inches, indicating good growth since most of the northern pike were likely three years old or less (Figure 7).

Bluegill:

Prior to either drawdown, Marion Millpond supported a high-density bluegill fishery with bluegill relative abundance averaging 445.6 bluegill per mile of electrofishing in 2004 (Figure 4). As expected, bluegill densities decline dramatically following each of the drawdowns. Bluegill CPUE in fall 2007 was only 12.6 bluegill per mile of electrofishing, and was only 22.0 per mile of electrofishing in fall 2010 (Figure 4). Bluegill population densities increased very quickly following each drawdown (Figure 4). By spring 2009, only two years after Marion Millpond was drawn up, bluegill densities had increased to 725.0 per mile of electrofishing (Figure 4). A similar trend was observed following the second drawdown, when bluegill CPUE reached 452.0 per mile of electrofishing in spring 2012, again just two years after the pond was drawn back up following the second drawdown. Between 2012 and 2017, bluegill densities remained high, ranging from a low of 249.0 bluegill per mile of electrofishing in spring 2014, to a high of 579.0 per mile of electrofishing in spring 2017 (Figure 4). A bluegill density of 579.0 per mile of electrofishing is a very high density for the state of Wisconsin, ranking in the 98th percentile when compared to spring electrofishing surveys throughout the state of Wisconsin.

As would be expected with very high densities of bluegill, the size structure of bluegill in Marion Millpond was dominated by smaller individuals. Prior to the drawdowns, bluegill size structure was the best of any of the electrofishing surveys when the mean length of bluegill captured was 5.5 inches, with a range of 3.2 – 7.2 and a PSD of 28 (Table 5; Figure 5). The majority of the bluegills captured in 2004 were between 4.5 and 7 inches (Figure 8). The mean length of bluegill sampled was > 5.0 inches in only one electrofishing sample, the spring 2014 electrofishing sample, and bluegill PSD values were < 22 in every electrofishing sample following both drawdowns (Table 5; Figure 5). Furthermore, bluegills >7.0 inches were only captured in five of the twelve electrofishing surveys that were conducted following the first drawdown (Table 5; Figure 8). Annual electrofishing samples also have shown that bluegill growth in Marion Millpond has been slow to moderate following the latest drawdown. The 2010 year class appears to be a very strong year class and can be followed through time on the length frequency histograms (Figure 8). This year class was the big spike between 2.0 – 3.0 inches seen in the spring 2011 electrofishing survey when these fish were age-1 (Figure 8). This year class appears to be 5 – 6 inches by age-3, which is similar to growth estimates from otoliths taken from the 2013 fyke netting survey. Growth appears to slow through time as densities of bluegill in Marion Millpond increased significantly. Growth data collected from the 2017 netting survey shows that some age-7 bluegill were still only 5.5 – 6.4 inches in Marion Millpond (Figure 8; Table 7).

Pumpkinseed:

Similar to results from the netting surveys, electrofishing surveys also showed that pumpkinseed densities in Marion Millpond were much higher following the drawdowns than were observed before the drawdowns. Pumpkinseed densities were found to be at 6.8 pumpkinseed per mile of electrofishing in the fall of 2004, prior to either drawdown (Figure 4). Pumpkinseed densities in every electrofishing survey from 2007 through 2017 were higher than what was observed in 2004 (Figure 4). Interestingly, pumpkinseed densities peaked exactly two years after each drawdown, reaching 390.0 and 355.0 pumpkinseed per mile of electrofishing in spring 2009 and spring 2012 (Figure 4). However, Marion Millpond was drawn down again later in 2009 so we don't know if pumpkinseed densities would have peaked in 2009 had the impoundment not been drawn back down. Following a steep decline in pumpkinseed density between spring 2012 and spring 2013, pumpkinseed densities have slowly climbed between spring 2013 and spring 2017, reaching 196.0 pumpkinseed per mile of electrofishing in 2017 (Figure 4). Pumpkinseed densities of 196.0 per mile of electrofishing are very high for the state of Wisconsin, falling into the 99th percentile when compared to spring electrofishing surveys throughout the state of Wisconsin.

Similar to bluegill, pumpkinseed size structure was the best in the pre-drawdown electrofishing in fall 2004 when densities were the lowest. During the fall 2004 survey, the average length of pumpkinseed in Marion Millpond was 6.2 inches, with a range of 5.2 – 7.1 inches, and a PSD of 71 (Table

5; Figure 5). Pumpkinseed size structure following both drawdowns was poor, as pumpkinseed had a mean length > 5.0 inches in only three of the 12 electrofishing surveys that have taken place since fall 2007 and the highest PSD in any of the same surveys was 14, indicating a very low percentage of the population is > 6.0 inches (Table 5). Pumpkinseed growth appears similar to bluegill growth. Most of the pumpkinseed captured in the fall 2010 and spring 2011 survey were 2 – 4 inches long and likely had completed 1 or 2 growing seasons (i.e., were age-1 or age-2; Figure 9). This group of pumpkinseeds grew to 4.0 – 6.0 inches by spring 2012 and reached 5.0 – 6.5 inches by spring 2014, when they were likely 4 - 5 years old. Following the first drawdown from 2006 – 2007, pumpkinseeds > 7.0 inches were only captured in two of the 12 electrofishing surveys conducted (i.e., spring 2015 and spring 2016; Table 5; Figure 9).

Black Crappie:

For the last 15 years, Marion Millpond has had a low density black crappie population with highly variable recruitment. Prior to the drawdown, black crappie densities were found at 4.9 black crappie per mile of electrofishing (Figure 4). Between 2007 and 2009 (i.e., during the recovery of the fishery following the first drawdown), black crappie densities were never found to be higher than 5.0 black crappies per mile of electrofishing (Figure 4). Black crappie densities peaked in 2010, the first year following the second drawdown, when black crappie densities were over 20 per mile of electrofishing (Figure 4). Black crappie densities decreased in each subsequent year until no black crappies were captured in 2013 and 2014 electrofishing surveys (Figure 4). A slight increase was observed in 2017, when black crappie densities reached 7.0 per mile of electrofishing (Figure 4). A black crappie density of 7.0 black crappies per mile of electrofishing is a moderate density for the state of Wisconsin, falling out in the 53rd percentile when compared to statewide spring electrofishing surveys.

It is likely that all the black crappies captured in the fall 2004 electrofishing survey were from one year class as they ranged in size from 7.4 – 8.4 inches (Table 5; Figure 10), indicating highly erratic recruitment before the drawdowns. The only strong year classes that were produced following the drawdowns appear to be the 2010 year class and the 2016 year class (Figure 10). However, few members of the 2010 year class were captured after the spring 2012 survey when this year class was 4.0 – 5.5 inches and they were two years old (Figure 10). Six individuals between 3.0 – 4.0 inches were captured in the spring 2017 electrofishing survey, likely meaning they were from the 2016 year class and were one year old in spring 2017 (Figure 10).

Yellow Perch:

Yellow perch densities may have changed the most among any of the gamefish or panfish species in Marion Millpond between pre- and post-drawdown sampling. Prior to the first drawdown, only one yellow perch per mile of electrofishing was captured in the fall 2004 electrofishing survey (Figure 4). Since monitoring of the recovery of the fishery following the first drawdown began in fall 2007, yellow perch densities were ≥56.0 yellow perch per mile of electrofishing in every survey, were ≥108.0 yellow perch per mile of electrofishing in nine of the 12 electrofishing surveys that have taken place since 2007, and yellow perch densities peaked in spring 2011 when densities reached 540.0 yellow perch per mile of electrofishing (Figure 4). Following the peak in yellow perch density that occurred in spring 2011, densities have declined but remained high, fluctuating between 56.0 and 244.0 yellow perch per mile of electrofishing (Figure 4). In 2017, yellow perch densities were found at 108.0 yellow perch per mile of electrofishing (Figure 4), ranking out in the 96th percentile statewide when compared to other spring electrofishing surveys throughout the state of Wisconsin.

Size structure of yellow perch in Marion Millpond has remained very poor following both of the drawdowns. The mean length of yellow perch captured in electrofishing surveys was <6.0 inches in 11 of the 12 electrofishing surveys that have taken place since 2007, when monitoring of the recovery of the fisheries after the initial drawdown began (Table 5). Some large adult yellow perch (i.e., > 8.0 inches) were captured in the first couple of electrofishing surveys that were conducted immediately following each drawdown as the electrofishing surveys in spring 2008, fall 2010, and spring 2011 were the only surveys in which yellow perch PSD values were > 10 (Figure 5; Figure 11). These large adults were likely from the adults that were stocked shortly after Marion Millpond was drawn up in 2007 and again in 2010. Once these stocked adults were harvested or died, few if any large yellow perch were captured in Marion Millpond as PSD values have remained < 5 in all other electrofishing surveys (Figure 5). Growth of naturally reproduced yellow perch appears slow in Marion Millpond. For example, there was a large group of yellow perch that were mostly 3 – 4.5 inches in the fall 2010 and spring 2011 surveys (Figure 11). These yellow perch were likely age-1, from the 2010 year class, but may have also had some age-2 yellow perch. This large group appears to have grown to only 4.5 – 6.0 inches in spring 2012, and 5.5 – 7.0 inches by spring 2014, when they were likely four or five years old (Figure 11). Subsequent year classes seem to show similar growth patterns when looking at length frequency histograms (Figure 11).

Discussion:

Bluegill, pumpkinseed, and yellow perch densities exploded within two years following the latest draw up in spring 2010. In spring 2011, just one year after the Marion Millpond was drawn back up following the latest drawdown, yellow perch densities were observed at 540 yellow perch per mile of electrofishing. By spring, 2012, just two years after Marion Millpond was drawn up again for the second time, bluegill densities reached 452 bluegill per mile of electrofishing and pumpkinseed densities reached 355 pumpkinseed per mile of electrofishing. Within two years after the latest drawdown, panfish densities in Marion Millpond were some of the highest observed in the state of Wisconsin, and panfish densities have remained high through 2017. The biggest fisheries management concern when panfish densities explode is density dependent competition for resources among the panfish (Swenson et al. 2000). When panfish densities are high and there is significant competition for limited resources, panfish growth and size structure are going to be poor. Results from WDNR surveys over the past 15 years have shown that panfish populations in Marion Millpond are exhibiting slow growth and poor size structure.

The stocking strategy following the latest drawdown likely resulted in the observed population trends in panfish. Over 10,000 adult bluegill, yellow perch, and black crappie were all stocked in March or April, 2010. All three of these species were stocked early enough in the year and were stocked at large enough sizes to spawn in spring, 2010. However, only yearling largemouth bass were stocked in spring 2010 along with 40 field transferred bass from Kinney Lake. Large fingerling northern pike were not stocked until fall 2010. Furthermore, the yearling largemouth bass averaged only 3.9 inches long and the fall fingerling northern pike averaged 8.4 inches long. Low numbers of predominantly very small predators are going to have a difficult time capturing larger prey fish with large spines and the body shape of bluegill and pumpkinseed. Because of this, it is not recommended to stock bluegills or crappies until one to two years after a predator population has been established with stocking (Swenson et al. 2000). Waiting to stock panfish for a year or two gives largemouth bass and northern pike the opportunity to grow to sizes in which they can more easily forage on young of the year prey fish. Furthermore, most northern pike don't mature until they are two or three years old and largemouth bass may not mature until they are three or four years old (Becker 1983). Waiting a year or two to stock panfish also allows predators to reach ages in which they can begin to reproduce and naturally increase the numbers of predators that are available to control prey densities.

Different stocking strategies were used in two other impoundments in Waupaca County following long drawdowns (i.e., Iola Millpond and Weyauwega Millpond) and these stocking strategies resulted in much different panfish populations in these two impoundments. Both Iola Millpond and Weyauwega Millpond were drawn down from summer, 2011 – spring, 2013. Largemouth bass were stocked in both impoundments from 2013 – 2015 and northern pike were stocked in both impoundments in 2013 and 2014. No panfish were stocked in Iola Millpond until bluegill were stocked in

2016 and no panfish were stocked into Weyauwega Millpond until adult yellow perch and black crappie were stocked during summer and fall, 2014, meaning these two species could not reproduce until 2015. Bluegill were not stocked into Weyauwega Millpond until 2016. Spring 2017 electrofishing surveys of Iola Millpond found bluegill densities to be 139.3 bluegill per mile of electrofishing, bluegill PSD to be 48, 23.3 bluegill ≥ 7 inches per mile of electrofishing were captured, and bluegills up to 9.4 inches were captured. Spring 2017 electrofishing surveys of Weyauwega Millpond found bluegill densities to be 68.0 bluegill per mile of electrofishing, bluegill PSD to be 58, 17.0 bluegill ≥ 7 inches per mile of electrofishing were captured, and bluegills up to 8.8 inches were captured. Establishing predator populations in Iola Millpond and Weyauwega Millpond prior to stocking any panfish has resulted in predators being able to more effectively control panfish densities. Lower densities of bluegill and other panfish results in much faster growth rates and larger size structure among the panfish populations.

Another factor that could also be affecting bluegill size structure and growth rates in Marion Millpond is their social structure during spawning. Bluegills are somewhat unique among upper Midwestern freshwater fish in that their social structure affects male spawning success. Bluegills build spawning nests in colonies and male bluegills will compete for the best spawning locations in the center of the colonies where the nests will have the lowest chances of experiencing nest predation (Gross and MacMillan 1981). Small bluegills that cannot effectively compete with larger males for the best nests will devote little energy towards reproduction until they grow to sizes where they can compete for the best nests (Jennings et al. 1997; Aday et al. 2006; Hoxmeier et al. 2009). When larger males are not present, smaller males will mature at a younger age and size and devote more resources to gonad development rather than growth (Jennings et al. 1997; Aday et al. 2003; Aday et al. 2006; Hoxmeier 2009). Therefore, the largest male bluegills in the population can drive the overall size structure of the bluegill population by dictating the size at maturation. Given the fact there are few large bluegills in Marion Millpond because of slow growth and intense fishing pressure, males don’t have to grow large to secure the best nest sites. Slow growth rates combined with maturation at small sizes due to their social structure means it will likely lengthen the amount of time it takes before the bluegill population in Marion Millpond consists of a significantly higher proportion of individuals ≥ 7 inches (Bear and Essington 2000).

One of the benefits of a high density panfish population that is predominantly comprised of smaller, slow growing individuals is that there is ample forage available for predatory fish species. As discussed earlier, both largemouth bass and northern pike likely exhibited fast growth following each of the drawdowns, undoubtedly because of the vast amounts of food available. However, despite fast growth, few large northern pike or largemouth bass were captured during sampling. Only 10% of the northern pike captured in the 2017 fyke net survey were above the 26-inch minimum length limit and 2017 was the only recent fyke netting survey where no northern pike > 30 inches were captured. Furthermore, few largemouth bass > 16-17 inches were captured in many of the electrofishing surveys. Angler exploitation could be driving the observed trends in size structure by harvesting most of the legal sized northern pike and largemouth bass.

Similar to many shallow impoundments in Wisconsin, Marion Millpond has a long history of having a high density of aquatic plants. One of the goals of the drawdowns that took place from 1969 – 1971 as well as 2006 – 2007 was to reduce the density of invasive aquatic plants in Marion Millpond. Research has shown that high densities of invasive aquatic plants can hinder the performance of many fish species, and especially visual predators such as northern pike and largemouth bass. For example, Savino and Stein (1982) found that largemouth bass were unable to capture bluegills in tanks with high densities of artificial plant stems. Their observations were that high densities of plants acted like visual barriers, preventing largemouth bass from seeing their bluegill prey (Savino and Stein 1982). If largemouth bass cannot effectively forage, their growth rates will decline. Furthermore, as was stated earlier, predation by largemouth bass and northern pike is what prevents panfish populations from becoming overcrowded and expressing slow, density dependent growth.

Similarly, Wiley et al. (1984) conducted hatchery pond experiments to evaluate the effects of aquatic plant densities on largemouth bass production. Their results showed that when plant densities were too high, largemouth bass could not effectively see their prey (i.e., bluegill) and the high density of plants acted as a refugia for the prey fish (Wiley et al. 1984). Furthermore, in a study of the effects that removal of submersed aquatic plants in Wisconsin lakes with high densities of invasive Eurasian water milfoil had on growth of bluegill and largemouth bass, Olson et al. (1998) observed faster growth rates in some age classes of bluegill and largemouth bass in lakes where invasive milfoil was removed in parts of the littoral zone by cutting lanes compared to lakes that experienced no removal. Interestingly, growth rates did not increase for all age classes of bluegill and largemouth bass following aquatic plant removal (Olson et al. 1998).

Black crappies recruitment in Marion Millpond appears to be highly erratic, meaning black crappies will pull off a strong year class and then may only produce very weak or no year class for several years in a row. Very few black crappies <7.0 inches were captured in the fall 2004 electrofishing survey or spring 2005 fyke netting survey, indicating few young individuals in the population at this time. Furthermore, the 2010 black crappie year class was strong and likely represented the 4.0 – 5.5 inch crappies captured in the spring 2012 electrofishing survey and the 5.0 – 6.5 inch crappies captured in the 2013 fyke net survey. After 2013, few if any black crappies were captured in Marion Millpond. Only seven black crappies were captured in the spring 2017 fyke net survey. There is some evidence that the crappies pulled off a year class in 2015 or 2016 as 6 black crappies between 3.0 and 4.0 inches were captured in spring 2017 fyke netting surveys. Black crappie recruitment has been shown to be highly variable in other waters throughout the United States (Hooe, 1991; Guy and Willis 1995; Allen and Miranda 1998). Stocking of adults in the future may be necessary to reestablish a self-sustaining, high quality black crappie fishery since natural reproduction is highly variable. The next comprehensive survey will provide additional insight regarding black crappie recruitment in Marion Millpond.

Summary and Management Recommendations:

Marion Millpond has a history of stocking either northern pike or largemouth bass and sometimes both species in every year since the last drawdown. Despite good numbers of both largemouth bass and northern pike being sampled in the 2017 comprehensive survey, it is evident that there is still a vast abundance of forage available in Marion Millpond as shown by the high density of small bluegill, yellow perch, and pumpkinseed. Additionally, both largemouth bass and northern pike are growing to large sizes and were healthy in 2017. Increasing numbers of predators or allowing predators to forage more effectively, is going to be the best method to try to reduce the numbers of panfish and increase panfish growth rates and size structures, resulting in a more balanced fishery and a panfish fishery with a more desirable size structure.

Angler exploitation is likely affecting the size structure and density of both northern pike and largemouth bass. Although no creel surveys have been conducted, significant numbers of anglers have been observed fishing Marion Millpond, especially during winter. While Marion Millpond already has a restrictive special regulation for northern pike, an even more restrictive regulation could be considered, such as a minimum length limit of 32 inches and a bag limit of one. Given the size of northern pike captured in historical surveys (i.e., mid-30 inches) and how quickly the northern pike grew following the latest drawdown (i.e., a mean length of 23.9 just three years following the last draw up), northern pike could grow significantly larger than 32 inches in Marion Millpond. Furthermore, the current largemouth bass regulation is the statewide default regulation of a 14-inch minimum and a daily bag limit of 5. Largemouth bass have been growing fast and have the potential of reaching large sizes, but few largemouth bass > 16 – 17 inches have been captured, likely due to angler exploitation removing legal sized fish. A more restrictive largemouth bass regulation such as a minimum length of 18.0 inches and a daily bag limit of one would protect some of the largemouth bass from harvest and potentially create a trophy largemouth bass fishery. Currently, forage does not appear to be a limiting factor in Marion

Millpond. As mentioned earlier, the panfish population could use some more predation to reduce densities.

Very few bluegill >7.0 inches have been captured in netting or electrofishing surveys since the last drawdown. Two factors described earlier are likely driving the small size structure of bluegill: 1.) density dependent competition resulting in poor growth; and 2.) maturing at a small size and young age due to their social structure. One of the original experimental regulations proposed as part of the statewide experimental panfish regulation research may improve the size structure of bluegill in Marion Millpond. This regulation is: 25 panfish may be kept, except 5 or fewer can be bluegill or pumpkinseed over 7 inches. This regulation could help Marion Millpond by having anglers act like an additional predator and harvest some of the smaller bluegill (i.e., 5 – 7 inches), while at the same time protecting some of the larger male bluegills and preventing future generations of bluegill from maturing at younger, smaller sizes if they want to compete for the most successful nest locations. Delayed maturation to later ages will result in faster growth. Although this regulation was not included as one of the three experimental regulations that was finalized by the panfish management team to be included in the statewide research, this regulation was put in place on four lakes to evaluate the effects. One of these lakes was the Cloverleaf Chain of Lakes in Shawano County which has a history of having high density bluegill population dominated by smaller individuals. Furthermore, growth rates appear similar between the two waters, with the mean age of bluegill between 5.5 – 6.4 inches being 5.3 years for both waterbodies and the mean age of bluegill 6.5 – 7.4 inches being 5.5 years for Marion Millpond and 5.8 years for the Cloverleaf Chain of Lakes. If results from the four lakes (and especially the Cloverleaf Chain of Lakes) where this regulation was implemented show it can increase size structure, it should be considered as a tool to use to increase bluegill size structure in Marion Millpond.

Marion Millpond has a history of having high density of aquatic invasive plants that can negatively impact the fishery and fishing opportunities. One of the objectives of the drawdown between

2006 – 2007 was to reduce undesirable invasive vegetation by desiccation and freezing. Efforts should be made to prevent invasive aquatic plants from becoming too dense as well as promote native plants. Promoting native aquatic plants will help achieve the goal of a balanced fishery in Marion Millpond. It is recommended that the local conservation clubs or interested citizen groups work with water resources staff and others within the WDNR to manage aquatic plants to ensure invasive plant species do not become too overabundant and a diverse mix of native plants is maintained.

Literature Cited:

Aday, D. D., D. H. Wahl, and D. P. Philipp. 2003. Assessing population-specific and environmental influences on bluegill life histories: a common garden approach. Ecology 84:3370-3375.

Aday, D. D., D. P. Philipp, and D. H. Wahl. 2006. Sex-specific life history patterns in bluegill (Lepomis macrochirus): interacting mechanisms influence individual body size. Oecologia 147:31-38.

Allen, M. S., and L. E. Miranda. 1998. An age-structured model for erratic crappie fisheries. Ecological Modeling 107:289-303.

Anderson, R. O., and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 in B. R. Murphy and D. W. Willis, editors. Fisheries Techniques, 2nd edition, American Fisheries Society, Bethesda, Maryland.

Becker, G. C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. Madison, WI.

Born, S. M., T. L. Wirth, E. M. Brick, and J. O Peterson. 1973. Restoring the recreational potential of small impoundments. Wisconsin Department of Natural Resources Technical Bulletin 71. Madison, WI.

Folz, D. 1972. Boom shocker survey: Marion Pond, Waupaca County. Wisconsin Department of Natural Resources Intra-Department Memorandum. Waupaca, Wisconsin.

Guy, C. S., and D. W. Willis. 1995. Population characteristics of black crappies in South Dakota waters: a case for ecosystem specific management. North American Journal of Fisheries Management 15:754-765.

Hooe, M. L. 1991. Crappie biology and management. North American Journal of Fisheries Management 11:483-484.

Hoxmeier, R. J. H., D. D. Aday, and D. H. Wahl. 2009. Examining interpopulation variation in bluegill growth rates and size structure: effects of harvest, maturation, and environmental variables. Transactions of the American Fisheries Society 138:423-432.

Jennings, M. J., J. E. Claussen, and D. P. Philipp. 1997. Effect of population size structure on reproductive investment of male bluegill. North American Journal of Fisheries Management 17:516-524.

Olson, M. H., S. R. Carpenter, P. Cunningham, S. Gafny, B. R. Herwig, N. P. Nibbelink, T. Pellett, C. Storlie, A. S. Trebitz, and K. A. Wilson. 1998. Managing aquatic macrophytes to improve fish growth: a multi-lake experiment. Fisheries 23:6-12.

Primising, M. 1960. Boom shocker survey – Marion Millpond – Waupaca County. Wisconsin Conservation Department Intra-Department Memorandum. Wautoma, Wisconsin.

Savino, J. F., and R. A. Stein. 1982. Predator-prey interaction between largemouth bass and bluegills as influenced by simulated, submersed vegetation. Transactions of the American Fisheries Society 111:255-266.

Simonson, T., A. Fayram, J. Hennesey, and T. Treska. 2008. Lakes assessment protocol. Unpublished Guidance Document, Wisconsin Department of Natural Resources, Madison, WI.

Swenson, W., S. Nichols, S. Craven, J. Malison, T. Thrall, S. Marcquenski, and J. O. Peterson. 2000. Managing Wisconsin fish ponds. University of Wisconsin – Extension. Madison, Wisconsin.

Swingle, H. S. 1950. Relationships and dynamics in balanced and unbalanced fish populations. Alabama Polytechnic Institute, Agricultural Experimental Station Bulletin 274, Auburn, Alabama.

Wiley, M. J., R. W. Gordens, S. W. Waite, and T. Powless. 1984. The relationship between aquatic macrophytes and sport fish production in Illinois ponds: a simple model. North American Journal of Fisheries Management 4:111-119.

Wisconsin Department of Natural Resources. 2017a. Marion Millpond. Available: http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=294500&page=facts. Accessed 11/27/2017.

Wisconsin Department of Natural Resources. 2017b. Marion Millpond, Pigeon River Watershed (WR10). Available: http://dnr.wi.gov/water/waterDetail.aspx?wbic=294500. Accessed 11/27/2017.

TABLE 1. Stocking history of Marion Millpond, Waupaca County, Wisconsin from 1959 to 2016.

Species	Year	Age	Mean Length (Inches)	Number Stocked
BLACK CRAPPIE	2016	ADULT	7.0	2,000
NORTHERN PIKE	2016	LARGE FINGERLING	8.0	2,893
LARGEMOUTH BASS	2015	LARGE FINGERLING	1.9	5,776
NORTHERN PIKE	2015	LARGE FINGERLING	9.4	2,893
LARGEMOUTH BASS	2014	LARGE FINGERLING	3.2	2,650
NORTHERN PIKE	2014	LARGE FINGERLING	9.5	750
BLACK CRAPPIE	2013	ADULT	6.0	1,498
NORTHERN PIKE	2013	ADULT	14.0	500
LARGEMOUTH BASS	2013	LARGE FINGERLING	2.1	2,698
YELLOW PERCH	2012	ADULT	7.0	1,895
LARGEMOUTH BASS	2012	LARGE FINGERLING	3.0	2,695
NORTHERN PIKE	2012	LARGE FINGERLING	7.5	250
LARGEMOUTH BASS	2011	LARGE FINGERLING	3.0	5,396
NORTHERN PIKE	2011	LARGE FINGERLING	8.4	2,624
NORTHERN PIKE	2010	LARGE FINGERLING	8.4	2,790
BLUEGILL	2010	LARGE FINGERLING	1.8	2,990
BLACK CRAPPIE	2010	LARGE FINGERLING	1.8	1,985
LARGEMOUTH BASS	2010	YEARLING	3.9	1,195
BLUEGILL	2010	ADULT (BROODSTOCK)	5.0	3,000
YELLOW PERCH	2010	ADULT (BROODSTOCK)	6.0	5,000
BLACK CRAPPIE	2010	ADULT (BROODSTOCK)	6.0	2,500
NORTHERN PIKE	2009	SMALL FINGERLING	2.3	4,990
BLACK CRAPPIE	2008	YEARLING	3.0	3,000
NORTHERN PIKE	2008	LARGE FINGERLING	7.4	1,320
YELLOW PERCH	2007	ADULT	6.6	5,993
NORTHERN PIKE	2007	LARGE FINGERLING	12.0	150
BLUEGILL	2007	ADULT (FIELD TRANSFER)	5.8	862
PUMPKINSEED	2007	ADULT (FIELD TRANSFER)	6.0	177
WHITE SUCKER	2007	ADULT (FIELD TRANSFER)	18.3	37
YELLOW PERCH	2007	ADULT (FIELD TRANSFER)	7.8	4
BLACK CRAPPIE	2007	ADULT (FIELD TRANSFER)	8.0	244
GOLDEN SHINER	2007	ADULT (FIELD TRANSFER)	-	1
NORTHERN PIKE	2007	ADULT (FIELD TRANSFER)	18.2	36
BROWN BULLHEAD	2007	ADULT (FIELD TRANSFER)	13.8	144
LARGEMOUTH BASS	2007	ADULT (FIELD TRANSFER)	13.5	249
YELLOW BULLHEAD	2007	ADULT (FIELD TRANSFER)	10.9	16
WALLEYE	1972	FINGERLING	3.0	6,000
WALLEYE	1972	FINGERLING	9.0	1,000

TABLE 1 CONTINUED. Stocking history of Marion Millpond, Waupaca County, Wisconsin from 1959 to 2016.

Species	Year	Age	Mean Length (Inches)	Number Stocked
NORTHERN PIKE	1971	FRY	-	400,000
NORTHERN PIKE	1971	SMALL FINGERLING	-	2,320
WALLEYE	1971	FRY	-	500,000
YELLOW PERCH	1971	ADULT	-	600
BLUEGILL	1971	ADULT	-	15,300
LARGEMOUTH BASS	1971	SMALL FINGERLING	-	17,800
LARGEMOUTH BASS	1971	ADULT	-	300
DAPHNIA	1971	-	-	4 QUARTS
NORTHERN PIKE	1962	FRY	-	40,000
NORTHERN PIKE	1959	FRY	-	50,000
LARGEMOUTH BASS	1959	ADULT	-	30
LARGEMOUTH BASS	1959	SMALL FINGERLING	-	2,000

TABLE 2. Sample dates, number of nets used, number of net nights, and mean water temperature during netting for the spring fyke net surveys of Marion Millpond, Waupaca County, WI in 2005, 2013, and 2017.

Sample Dates	Number of Nets Used	Number of Net Nights	Mean Water Temperature °F (Range)
04/08/2005 - 04/14/2005	7	36	52.7 (48 - 56)
04/23/2013 - 04/29/2013	6	25	51.7 (41 - 58)
03/31/2017 - 04/08/2017	5	32	44.1 (42 - 46)

TABLE 3. Sample date, total miles shocked, miles where only gamefish were netted, miles where all fish were netted, water temperatures, and electrofishing boat settings for all spring and fall electrofishing surveys conducted on Marion Millpond, Waupaca County, WI between 2004 and 2017.

Sample Date	Total Miles Shocked	Miles where Only Gamefish were Netted	Miles where All Fish were Netted	Water Temperature °F	Electrofishing Boat Settings			
					Volts	Amps	Pulse Rate	Duty Cycle
10/12/2004	2.19	1.16	1.03	57.0	125	4	40	25
09/27/2007	2.19	1.16	1.03	67.8	125/160	8/14	70	25
05/13/2008	1.0	0.0	1.0	60.5	150	13	50	25
09/29/2008	1.0	0.0	1.0	64.0	140	14.5	60	25
05/06/2009	1.0	0.0	1.0	66.0	230	18	50	25
09/21/2010	1.0	0.0	1.0	59.0	170	17	50	25
05/24/2011	1.0	0.0	1.0	66.5	180	16	50	25
05/07/2012	1.0	0.0	1.0	60.0	175/185	14/15	55	25
05/16/2013	2.0	1.0	1.0	66.3	160/165	11	50	25
05/13/2014	1.0	0.0	1.0	58.5	160	12	50	25
04/27/2015	1.6	0.6	1.0	58.9	120/140	10	50	25
05/10/2016	1.0	0.0	1.0	59.0	190/200	16	50	25
05/04/2017	1.0	0.0	1.0	57.0	240	12.5	50	25

TABLE 4. Number captured and mean, minimum, and maximum length of each species sampled during spring fyke netting surveys conducted on Marion Millpond, Waupaca County, Wisconsin in 2005, 2013, and 2017.

	Spring 2005		**Spring 2013**		**Spring 2017**	
Species	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**
BLACK BULLHEAD	10	-	13,958	-	927	-
BLACK CRAPPIE	61	8.7 (4.8 - 14.0)	13	6.9 (4.8 - 10.9)	7	8.1 (5.6 - 11.9)
BLUEGILL	1,537	5.7 (3.9 - 7.7)	3,614	5.9 (4.5 - 8.5)	998	6.0 (3.5 - 8.3)
BOWFIN	0	-	1	-	0	-
BROWN BULLHEAD	6	-	1,893	-	606	-
COMMON SHINER	0	-	9	-	0	-
GOLDEN SHINER	2	-	212	-	11	-
LARGEMOUTH BASS	76	13.3 (6.4 - 22.2)	63	13.8 (8.7 - 16.9)	7	17.3 (16.5 - 18.0)
NORTHERN HOG SUCKER	0	-	25	-	0	-
NORTHERN PIKE	87	23.7 (15.9 - 33.0)	203	23.9 (13.6 - 33.2)	296	20.9 (10.8 - 29.3)
PUMPKINSEED	80	5.8 (3.5 - 8.0)	135	5.6 (4.9 - 6.2)	298	4.9 (3.6 - 7.9)
WARMOUTH	4	-	10	-	2	-
WHITE SUCKER	3	-	832	-	1	-
YELLOW BULLHEAD	580	-	79	-	26	-
YELLOW PERCH	268	6.3 (5.1 - 9.5)	3,083	6.3 (4.7 - 10.3)	866	6.2 (5.0 - 9.5)

TABLE 5. Number captured and mean, minimum, and maximum length of each species sampled during all electrofishing surveys conducted on Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017.

	Fall 2004		Fall 2007		Spring 2008		Fall 2008	
Species	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**
BLACK BULLHEAD	0	-	0	-	0	-	2	-
BLACK CRAPPIE	5	7.9 (7.4 - 8.4)	0	-	2	3.7 (3.3 - 4.1)	5	6.1 (5.9 - 6.2)
BLUEGILL	459	5.5 (3.2 - 7.2)	13	2.8 (2.2 - 3.0)	180	2.9 (2.1 - 7.2)	210	4.6 (2.9 - 6.4)
BROWN BULLHEAD	11	-	0	-	0	-	21	-
COMMON SHINER	0	-	0	-	0	-	0	-
GOLDEN SHINER	0	-	25	-	22	-	2	-
LARGEMOUTH BASS	62	12.4 (5.0 - 18.4)	337	4.5 (2.9 - 19.5)	74	6.2 (2.8 - 16.1)	201	4.7 (3.6 - 12.1)
NORTHERN PIKE	4	19.3 (18.4 - 20.1)	0	-	2	21.3 (19.3 - 23.3)	3	20.8 (18.1 - 23.8)
PUMPKINSEED	7	6.2 (5.2 - 7.1)	80	3.2 (2.4 - 4.3)	244	3.5 (2.1 - 4.4)	76	4.7 (3.6 - 6.2)
SMALLMOUTH BASS	0	-	0	-	0	-	0	-
WARMOUTH	2	-	0	-	0	-	0	-
WHITE SUCKER	9	-	1	-	11	-	8	-
YELLOW BULLHEAD	0	-	1	-	0	-	8	-
YELLOW PERCH	1	6.0 (6.0 - 6.0)	205	4.0 (3.3 - 4.8)	411	4.5 (3.7 - 9.3)	394	5.3 (4.4 - 7.2)

TABLE 5 CONTINUED. Number captured and mean, minimum, and maximum length of each species sampled during all electrofishing surveys conducted on Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017.

	Spring 2009		**Fall 2010**		**Spring 2011**		**Spring 2012**	
Species	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**
BLACK BULLHEAD	3	-	13	-	18	-	179	-
BLACK CRAPPIE	0	-	24	3.5 (2.4 - 9.2)	20	3.8 (2.5 - 9.8)	14	5.0 (4.1 - 9.3)
BLUEGILL	725	4.4 (3.2 - 7.3)	22	3.3 (1.9 - 7.1)	44	3.1 (2.4 - 7.1)	452	4.3 (2.8 - 6.9)
BROWN BULLHEAD	35	-	0	-	6	-	13	-
COMMON SHINER	0	-	0	-	0	-	0	-
GOLDEN SHINER	4	-	18	-	21	-	12	-
LARGEMOUTH BASS	33	10.2 (4.6 - 15.6)	55	6.9 (3.4 - 10.8)	51	7.3 (5.8 - 10.2)	86	11.7 (6.6 - 15.8)
NORTHERN PIKE	3	20.2 (18.2 - 21.8)	1	7.8 (7.8 - 7.8)	1	14.2 (14.2 - 14.2)	3	18.0 (8.9 - 27.2)
PUMPKINSEED	390	4.6 (3.4 - 5.6)	12	3.2 (1.8 – 5.2)	73	3.3 (2.1 - 6.4)	355	4.7 (3.3 - 5.7)
SMALLMOUTH BASS	0	-	1	10.6 (10.6 - 10.6)	0	-	0	-
WARMOUTH	0	-	0	-	0	-	1	-
WHITE SUCKER	44	-	18	-	38	-	45	-
YELLOW BULLHEAD	10	-	0	-	0	-	4	-
YELLOW PERCH	234	5.7 (4.8 - 9.7)	167	3.9 (2.8 - 9.6)	540	4.5 (3.0 - 10.0)	244	5.3 (4.4 - 10.0)

TABLE 5 CONTINUED. Number captured and mean, minimum, and maximum length of each species sampled during all electrofishing surveys conducted on Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017.

	Spring 2013		Spring 2014		Spring 2015		Spring 2016	
Species	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**	**Number Captured**	**Mean Length (Range)**
BLACK BULLHEAD	194	-	69	-	107	-	82	-
BLACK CRAPPIE	0	-	0	-	2	9.2 (9.1 - 9.4)	1	3.6 (3.6 - 3.6)
BLUEGILL	323	4.9 (2.1 - 6.3)	249	5.3 (3.3 - 6.6)	349	4.9 (3.4 - 6.7)	362	4.8 (2.4 - 7.5)
BROWN BULLHEAD	41	-	31	-	57	-	49	-
COMMON SHINER	0	-	0	-	0	-	0	-
GOLDEN SHINER	39	-	25	-	17	-	17	-
LARGEMOUTH BASS	104	12.6 (5.4 - 17.1)	41	13.7 (8.1 - 17.2)	48	15.1 (8.0 - 18.9)	19	14.1 (6.1 - 19.3)
NORTHERN PIKE	7	21.4 (15.7 - 26.0)	2	16.4 (15.6 - 17.2)	9	22.1 (18.3 - 29.7)	4	21.4 (18.5 - 24.2)
PUMPKINSEED	98	5.4 (3.9 - 6.3)	83	5.3 (3.6 - 6.5)	159	5.0 (3.2 - 8.4)	115	4.4 (2.6 - 7.6)
SMALLMOUTH BASS	0	-	0	-	0	-	0	-
WARMOUTH	1	-	1	-	3	-	7	-
WHITE SUCKER	56	-	35	-	21	-	2	-
YELLOW BULLHEAD	4	-	3	-	1	-	3	-
YELLOW PERCH	68	6.0 (4.9 - 8.0)	80	5.9 (3.4 - 8.2)	56	4.6 (3.6 - 6.7)	161	4.9 (3.9 - 7.1)

TABLE 5 CONTINUED. Number captured and mean, minimum, and maximum length of each species sampled during all electrofishing surveys conducted on Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017.

	Spring 2017	
Species	**Number Captured**	**Mean Length (Range)**
BLACK BULLHEAD	24	-
BLACK CRAPPIE	7	4.2 (3.2 - 8.7)
BLUEGILL	579	4.1 (1.9 - 6.9)
BROWN BULLHEAD	27	-
COMMON SHINER	2	-
GOLDEN SHINER	24	-
LARGEMOUTH BASS	40	11.0 (2.6 - 17.8)
NORTHERN PIKE	11	21.2 (14.1 - 25.0)
PUMPKINSEED	196	4.5 (2.9 - 6.9)
SMALLMOUTH BASS	0	-
WARMOUTH	8	-
WHITE SUCKER	1	-
YELLOW BULLHEAD	9	-
YELLOW PERCH	108	4.7 (2.9 - 7.9)

TABLE 6. Summary statistics for northern pike marking (i.e., partial top caudal/tail fin clip) and recaptures from spring fyke netting surveys in 2005, 2013, and 2017 that were used to estimate northern pike abundance in Marion Millpond using a Schanbel mark-recapture model. Parameters included are the number of northern pike marked during netting, sampling year, number of sampling events (i.e., days the nets were checked), number of northern pike that were recaptured, the Schnabel population estimated including the 95% confidence intervals, and the number of northern pike per acre including the estimates based on confidence intervals.

Species	**Year**	**Number Marked (Netting)**	**Number of Sampling Events**	**Number Recaptures**	**Schnabel Population Estimate (95% Confidence Intervals)**	**Number per Acre**
Northern Pike	2005	71	6	8	Too few fish sampled	Too few fish sampled
Northern Pike	2013	177	6	12	Too few recaptures	Too few recaptures
Northern Pike	2017	250	8	44	728 (540 - 1,118)	6.3 (4.7 - 9.6)

TABLE 7. Summary statistics for bluegill growth rates from bluegill collected in a spring fyke netting survey of Marion Millpond, 2017. Statistics included are the sampling year, total number of bluegill collected, length bin of interest, mean age of the bluegill in the length bin of interest, age range of bluegill in the length bin of interest, percentile rank when compared to statewide bluegill growth rates, and the growth rating when compared to statewide bluegill growth rates.

Species	Year	Total Number Collected	Length Bin (Inches)	Mean Age (Years)	Age Range (Years)	Percentile Rank	Growth Rating
Bluegill	2017	10	5.5 - 6.4	5.3	5 -7	29th	Slow
Bluegill	2017	13	6.5 - 7.4	5.5	5 - 7	50th	Moderate

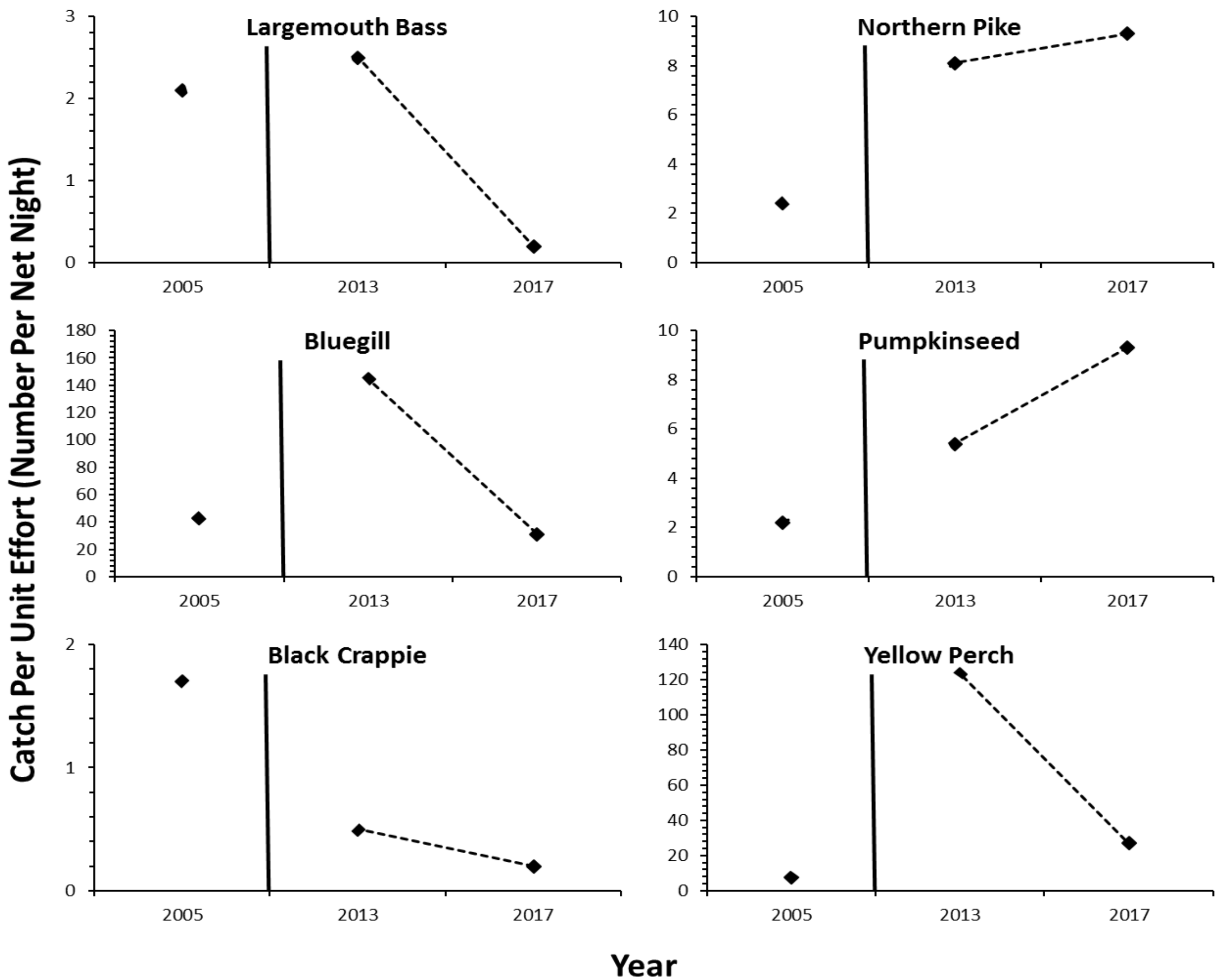

FIGURE 1. Changes in largemouth bass, northern pike, bluegill, pumpkinseed, black crappie, and yellow perch catch per unit effort from the three spring fyke netting surveys conducted in Marion Millpond, Waupaca County, WI in 2005, 2013, and 2017. The gap with the solid vertical line represents the separation between pre-drawdown sampling and post-drawdown sampling.

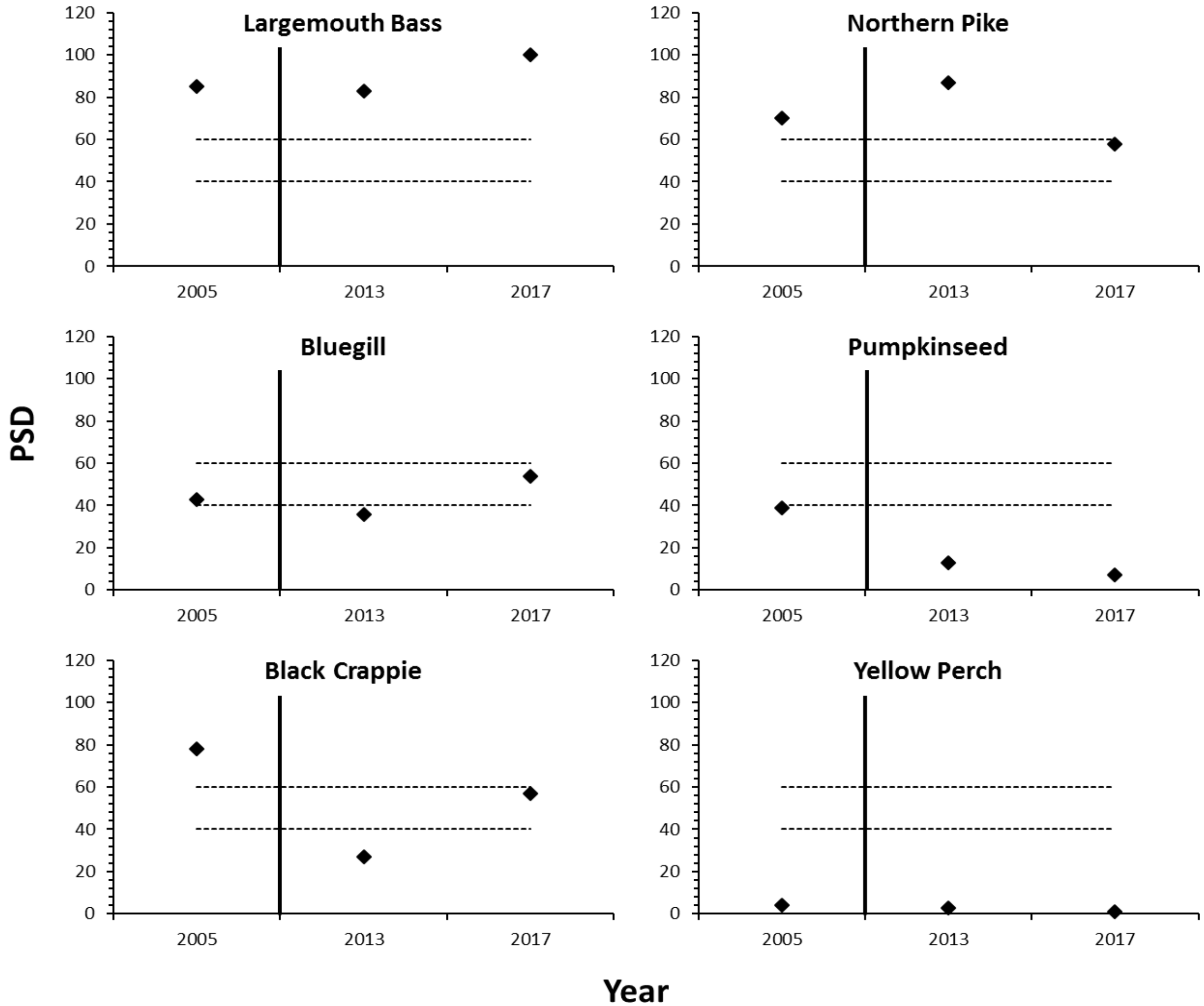

FIGURE 2. Changes in largemouth bass, northern pike, bluegill, pumpkinseed, black crappie, and yellow perch PSD from the three spring fyke netting surveys conducted in Marion Millpond, Waupaca County, WI in 2005, 2013, and 2017. The two dashed horizontal lines represent PSD values of 40 and 60. PSD values within this range represent a balance population. The solid vertical line represents the separation between pre-drawdown sampling and post-drawdown sampling.

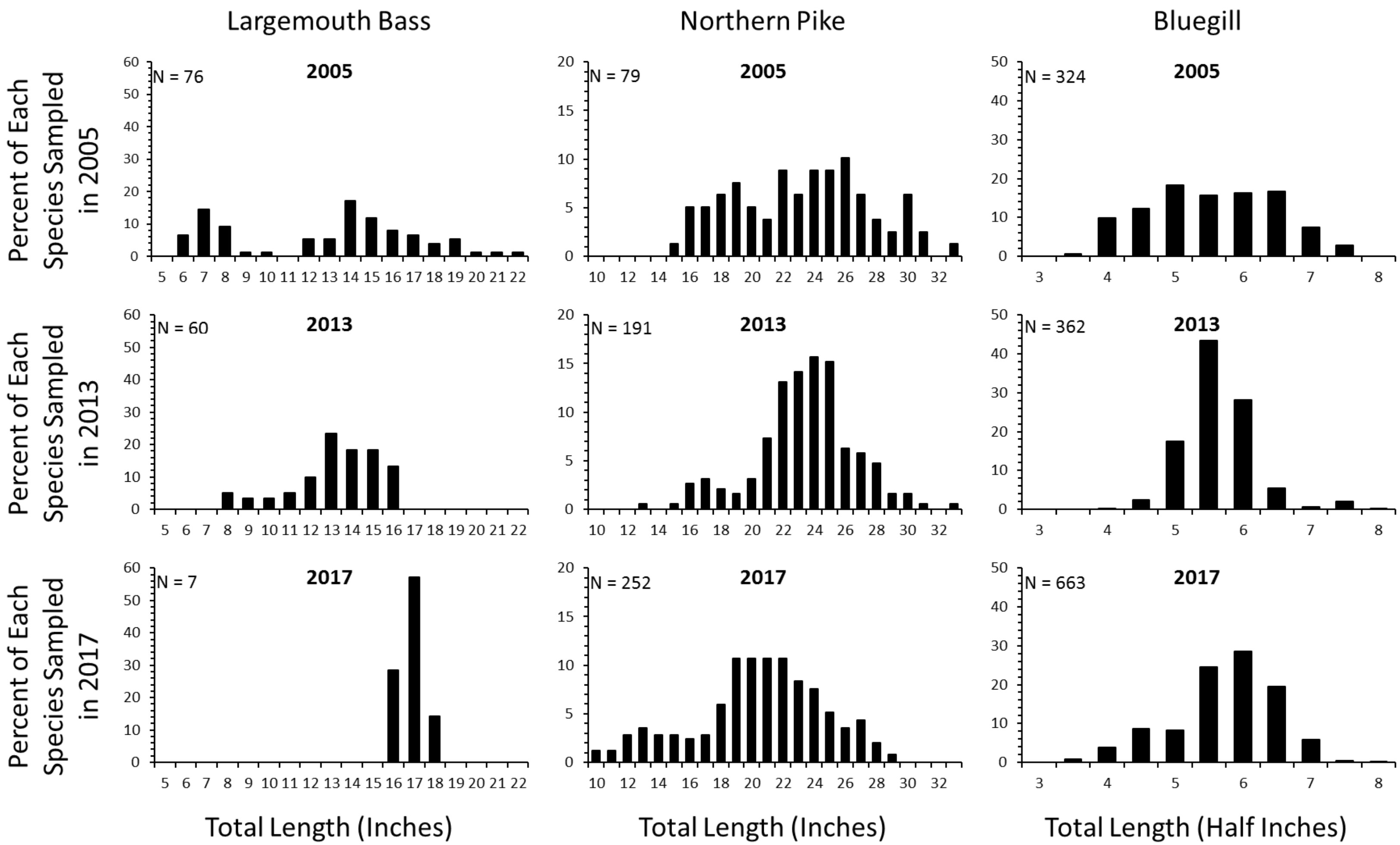

FIGURE 3. Length frequency distributions for largemouth bass, northern pike, bluegill, pumpkineed, black crappie, and yellow perch sampled during spring fyke netting surveys of Marion Millpond, Waupaca County, WI in 2005, 2013, and 2017. Total number of each species measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class for gamefish and half inch class for panfish. Length frequency histograms for 2005 represent pre-drawdown conditions whereas length frequency histograms in 2013 and 2017 represent post-drawdown conditions.

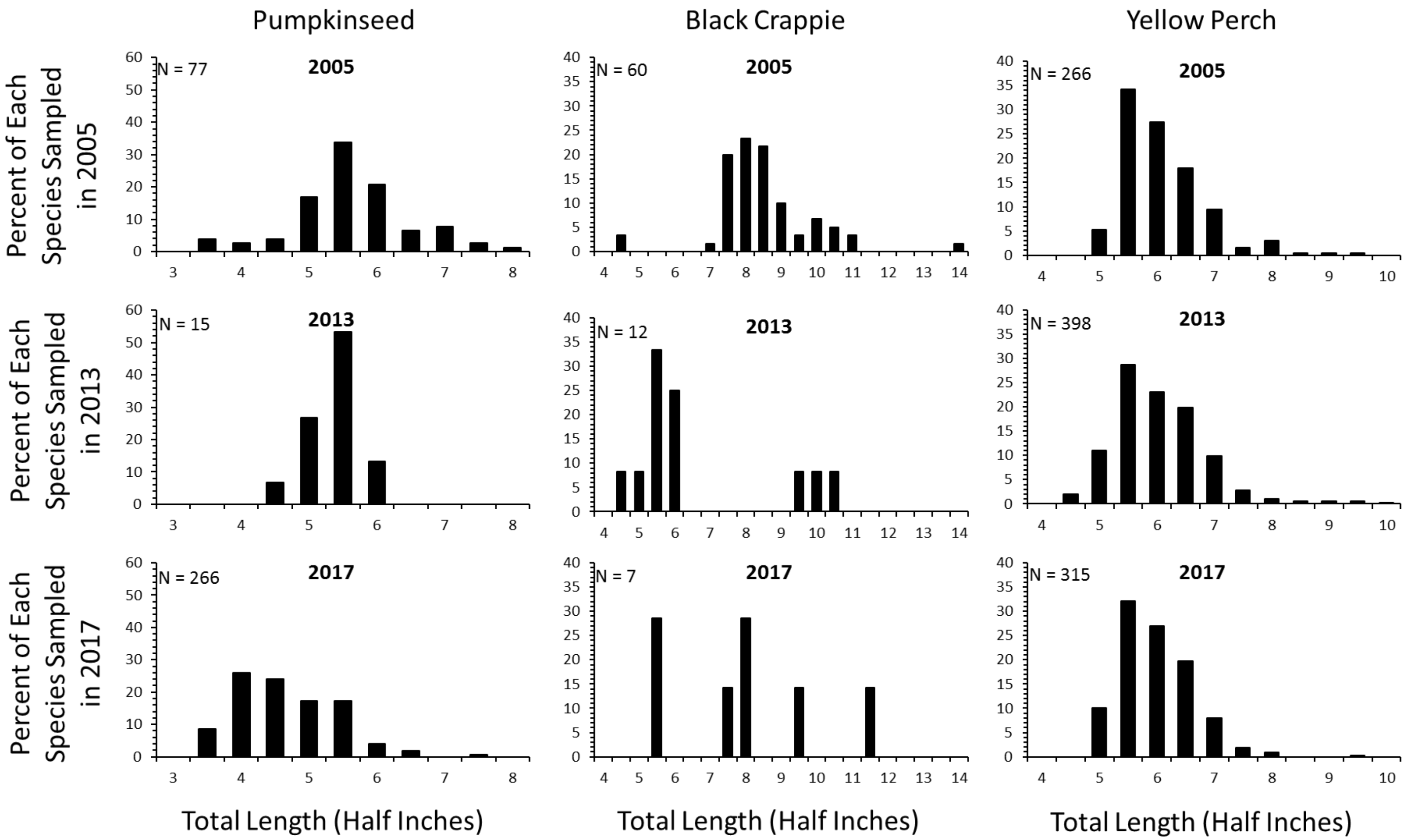

FIGURE 3 CONTINUED. Length frequency distributions for largemouth bass, northern pike, bluegill, pumpkineed, black crappie, and yellow perch sampled during spring fyke netting surveys of Marion Millpond, Waupaca County, WI in 2005, 2013, and 2017. Total number of each species measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class for gamefish and half inch class for panfish. Length frequency histograms for 2005 represent pre-drawdown conditions whereas length frequency histograms in 2013 and 2017 represent post-drawdown conditions.

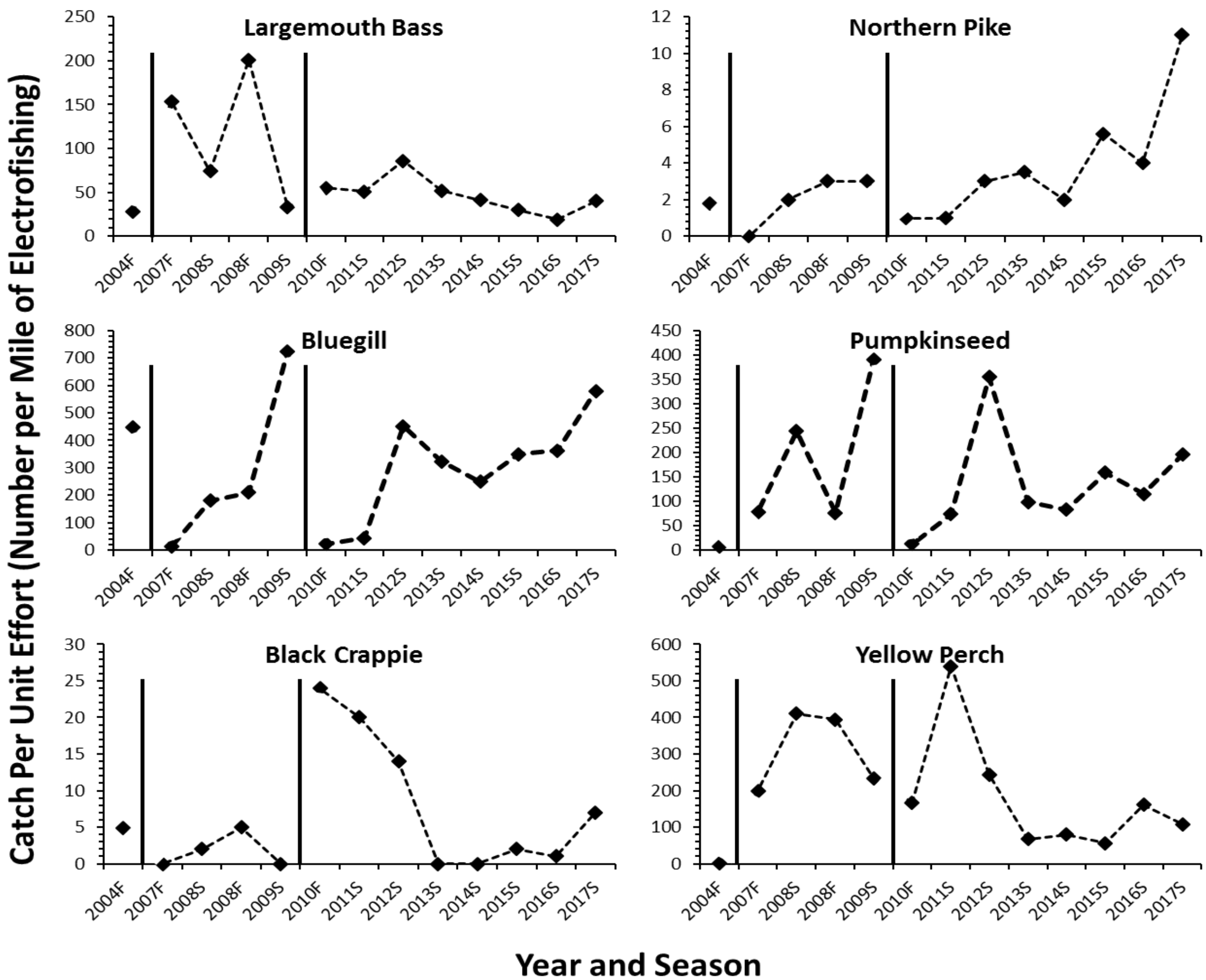

FIGURE 4. Changes in largemouth bass, northern pike, bluegill, pumpkinseed, black crappie, and yellow perch catch per unit effort from the thirteen electrofishing surveys conducted in Marion Millpond, Waupaca County, WI between 2004 and 2017. The gaps with the solid vertical lines represent the two drawdowns and separate catch per unit effort by drawdown.

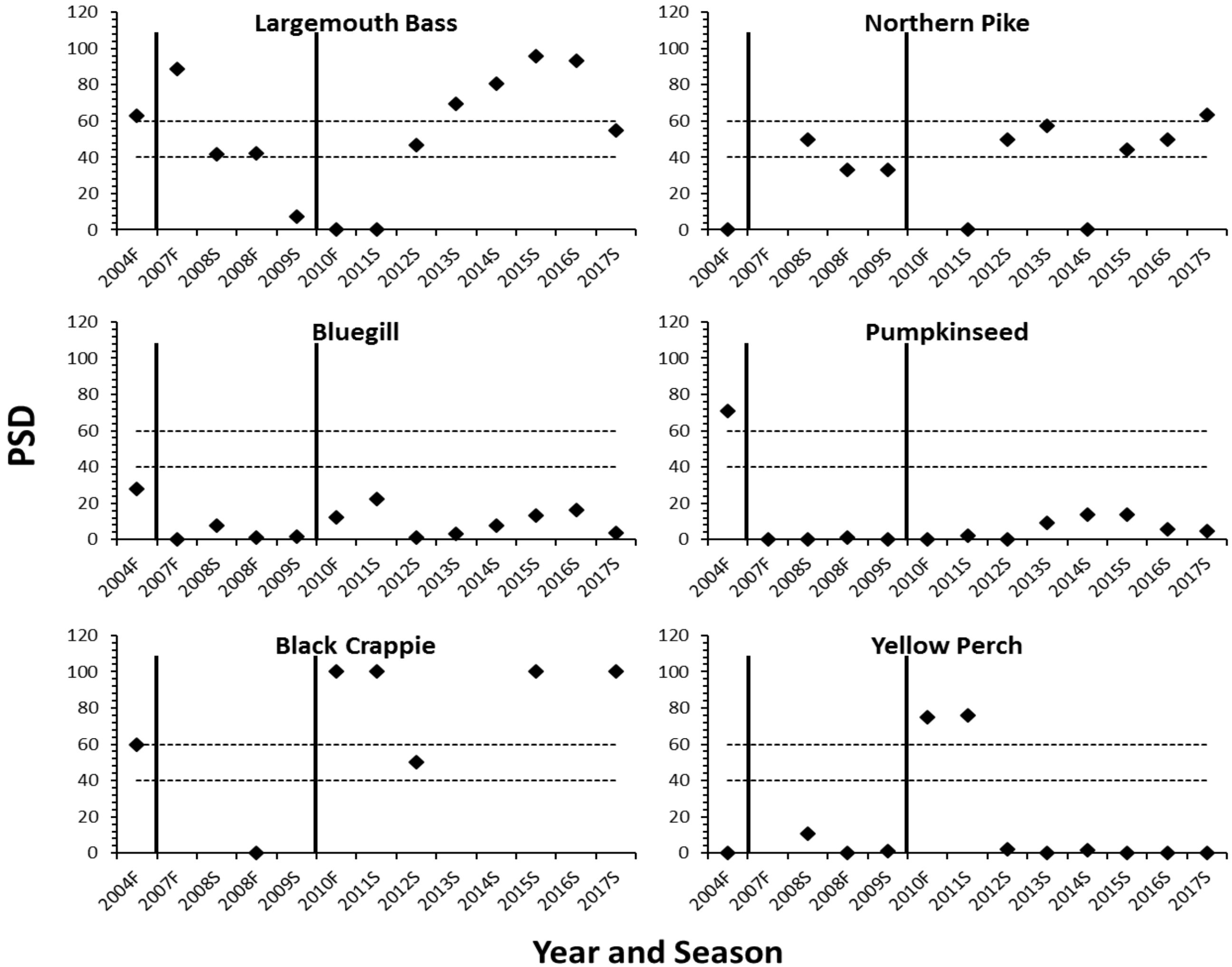

FIGURE 5. Changes in largemouth bass, northern pike, bluegill, pumpkinseed, black crappie, and yellow perch PSD from the thirteen electrofishing surveys conducted in Marion Millpond, Waupaca County, WI between 2004 and 2017. The two dashed horizontal lines represent PSD values of 40 and 60. PSD values within this range represent a balance population. The two solid vertical lines represent the two drawdowns and separate PSD values by drawdowns.

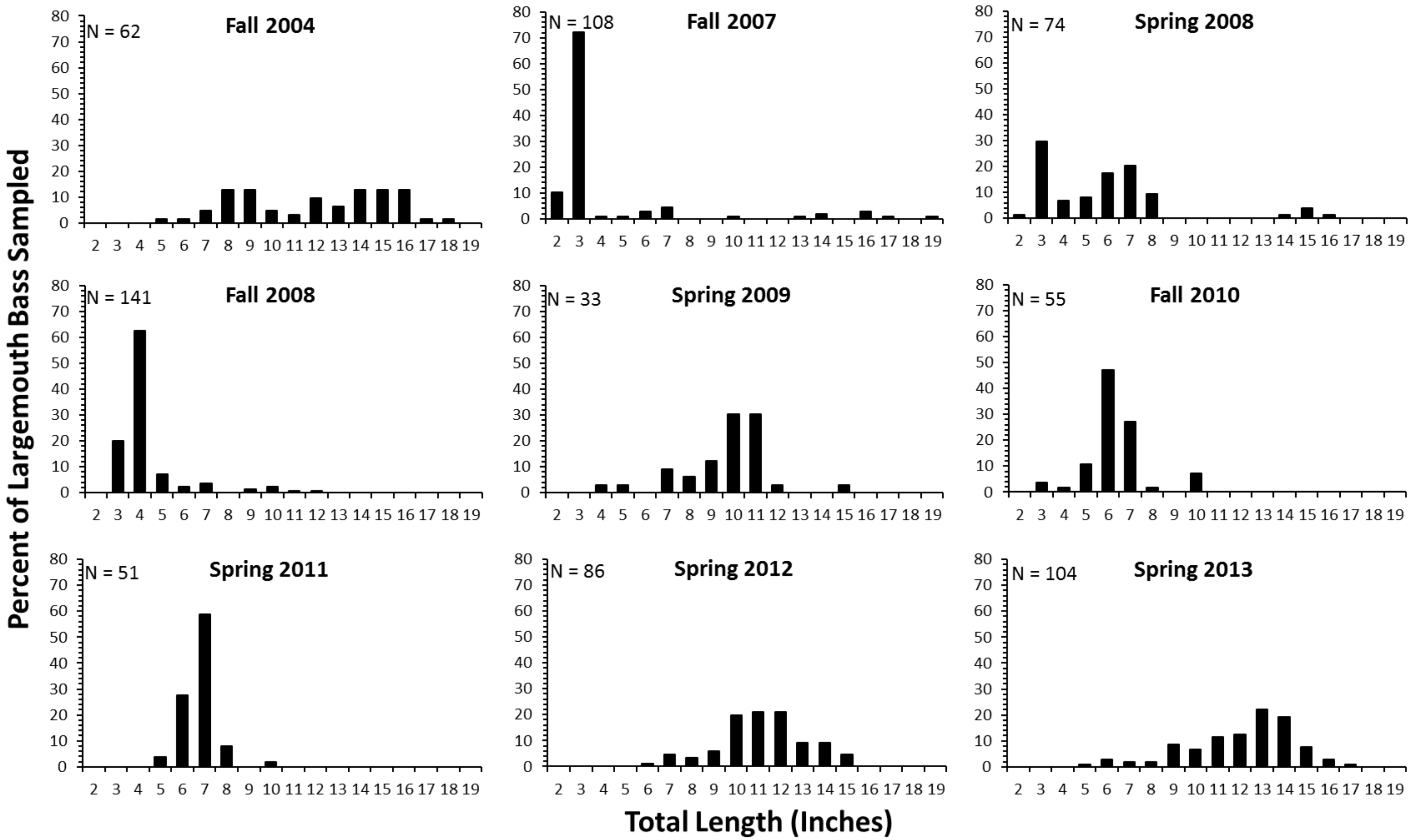

FIGURE 6. Length frequency distributions for largemouth bass sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of largemouth bass measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class.

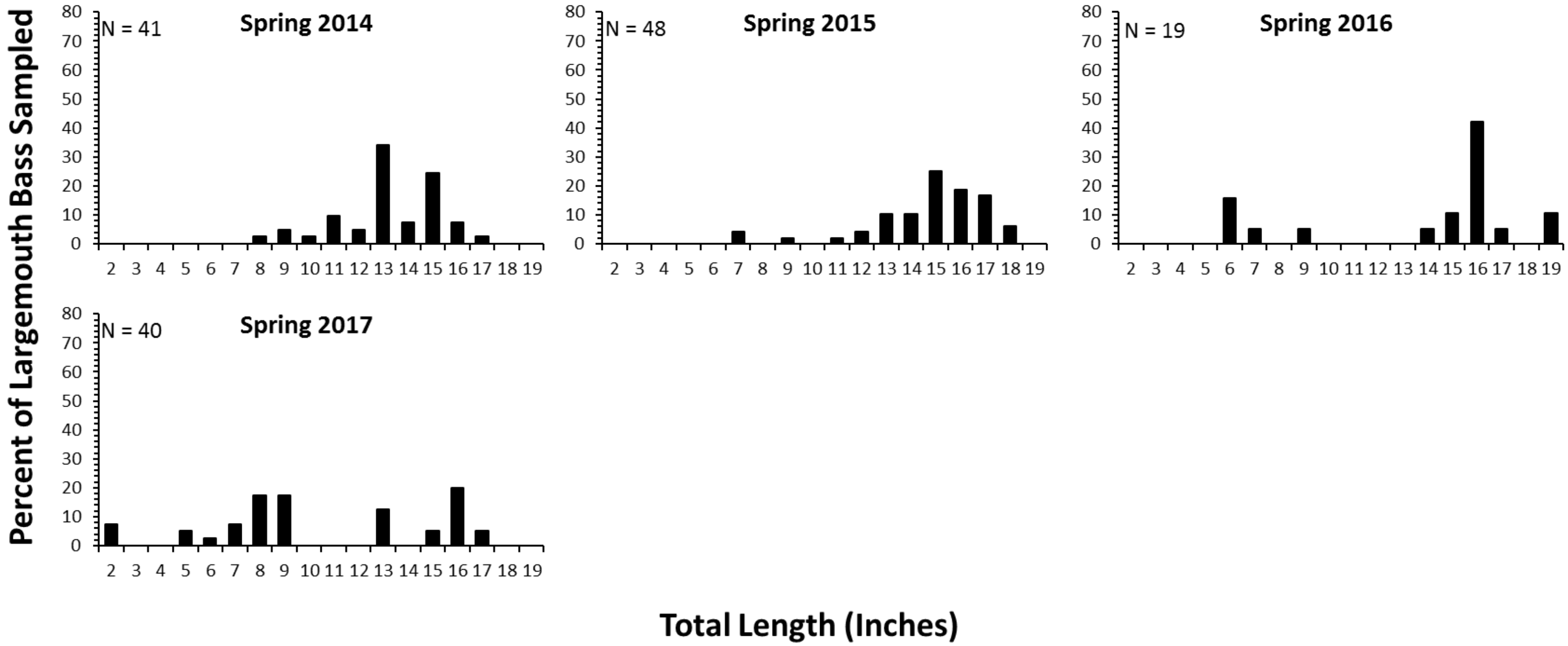

FIGURE 6 CONTINUED. Length frequency distributions for largemouth bass sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of largemouth bass measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class.

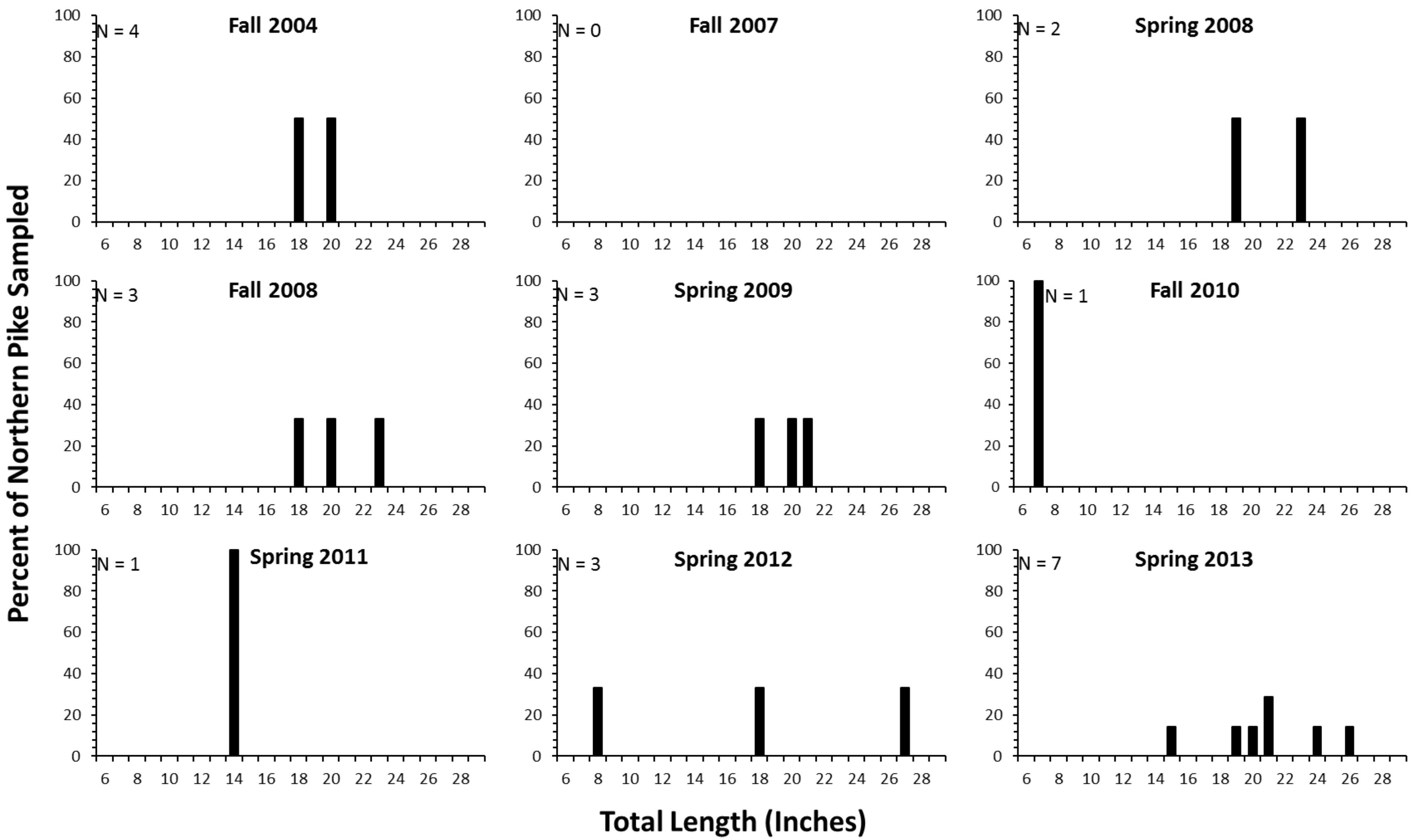

FIGURE 7. Length frequency distributions for northern pike sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of northern pike measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class.

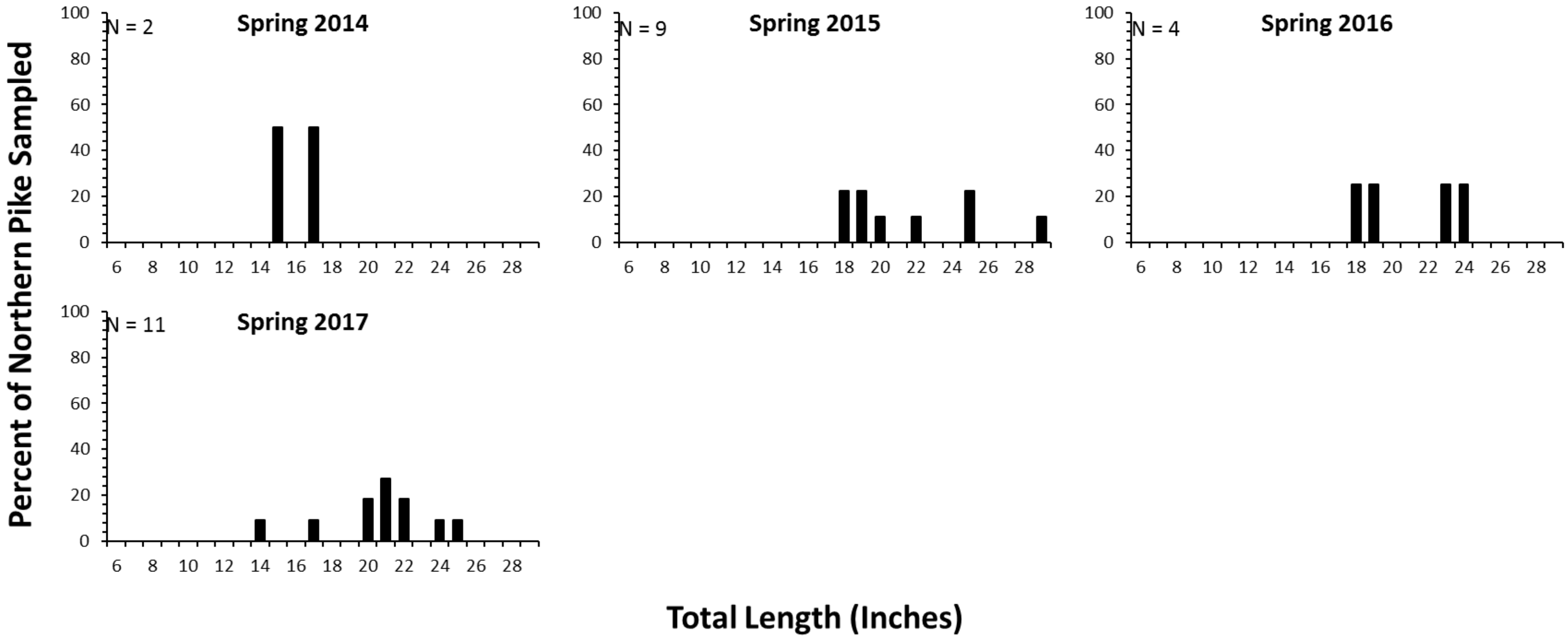

FIGURE 7 CONTINUED. Length frequency distributions for northern pike sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of northern pike measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each inch class.

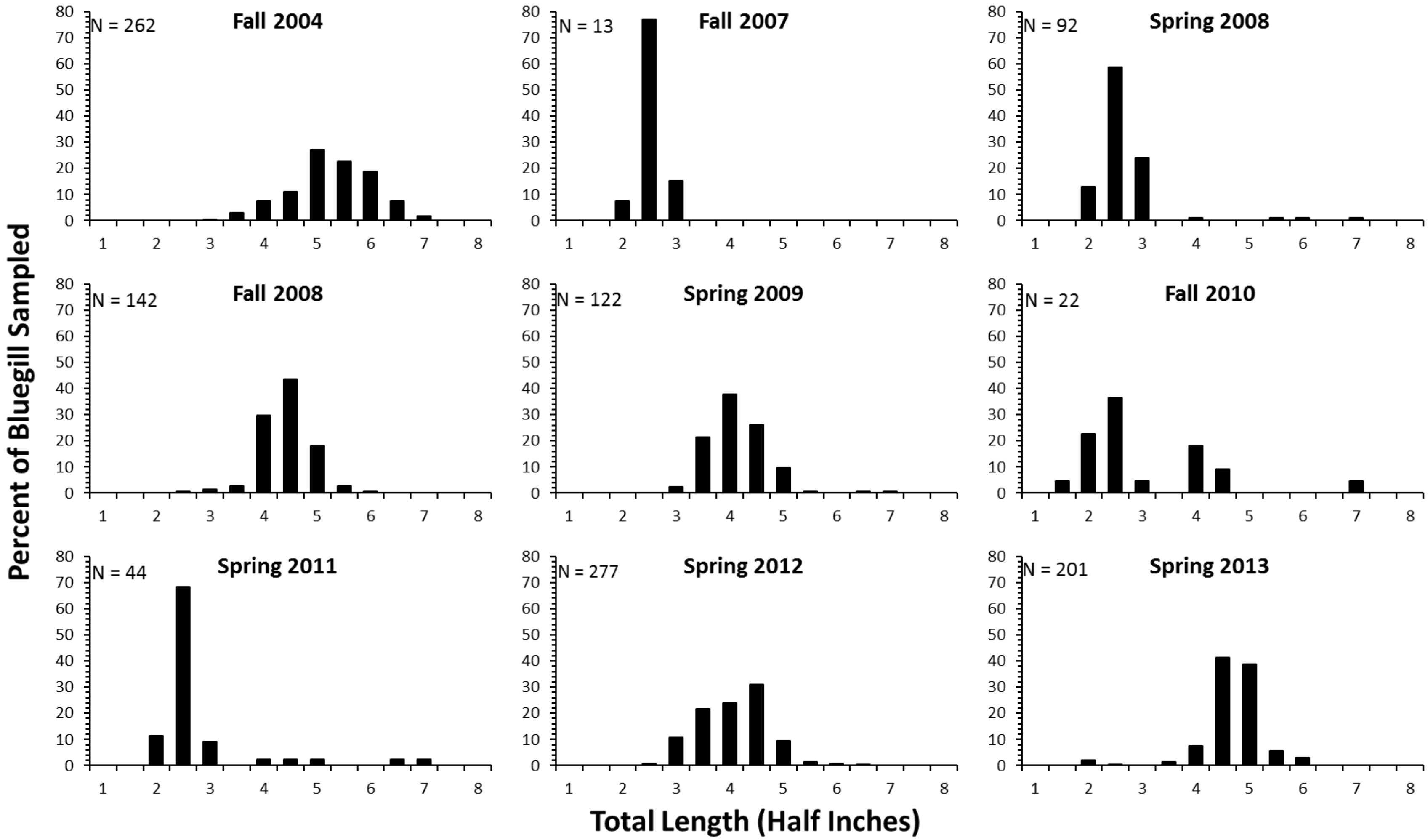

FIGURE 8. Length frequency distributions for bluegill sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of bluegill measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

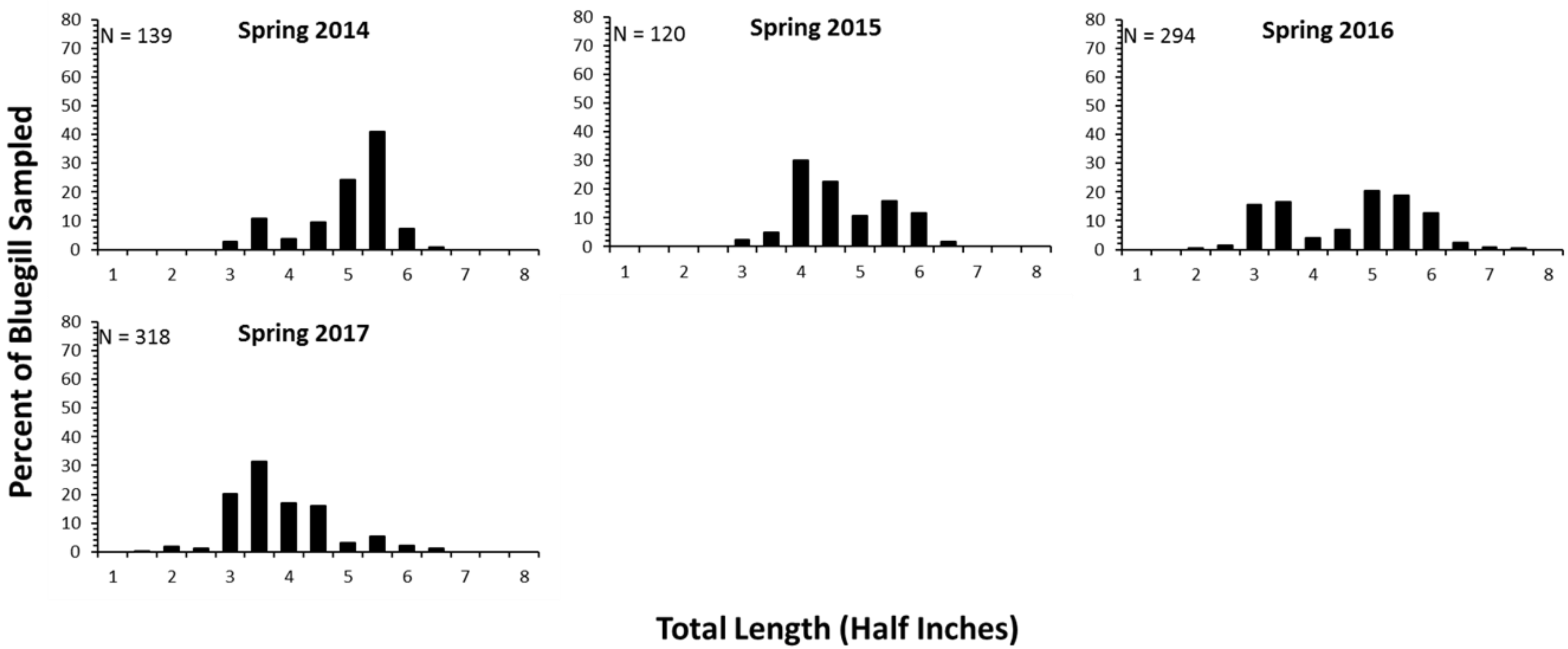

FIGURE 8 CONTINUED. Length frequency distributions for bluegill sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of bluegill measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

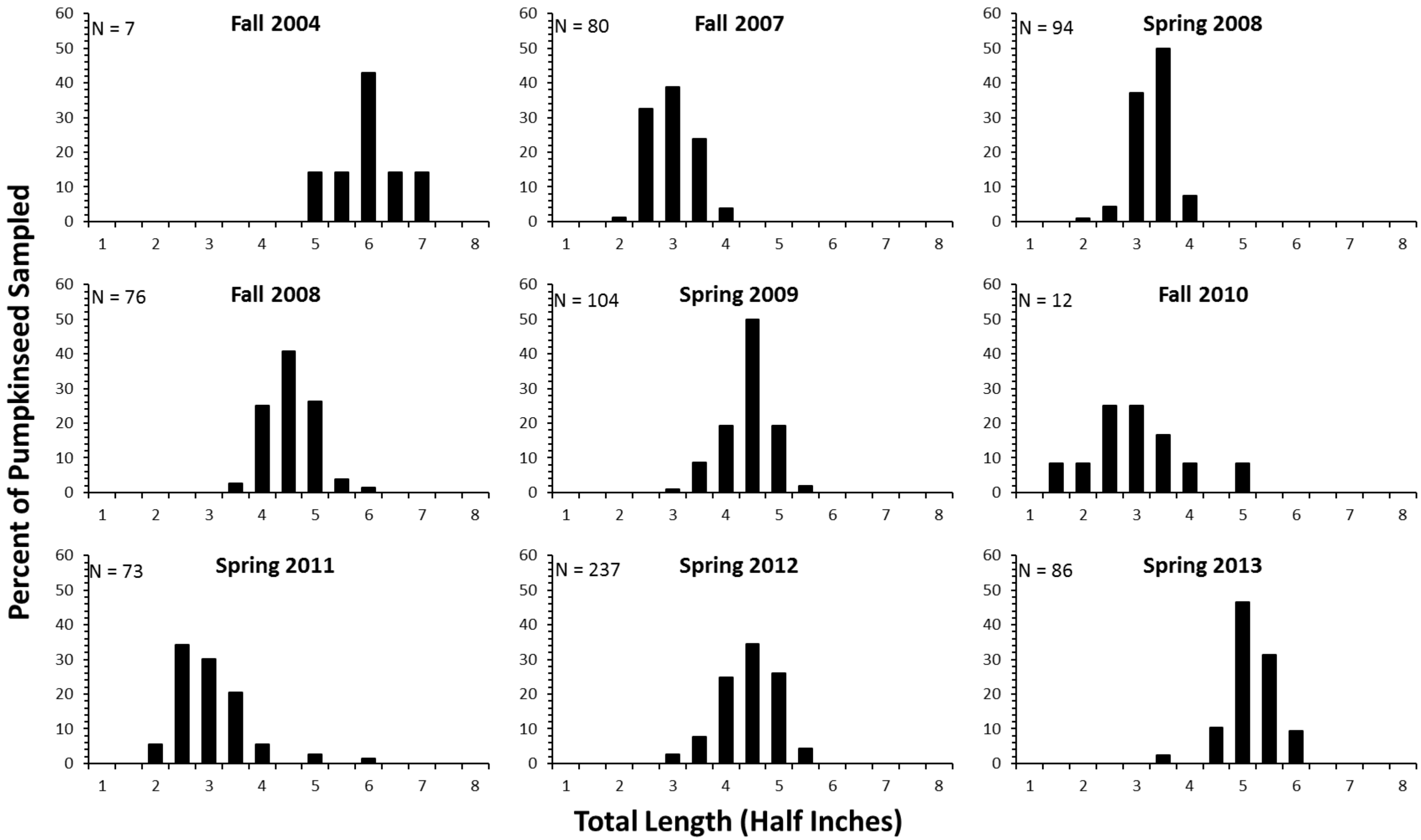

FIGURE 9. Length frequency distributions for pumpkinseed sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of pumpkinseed measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

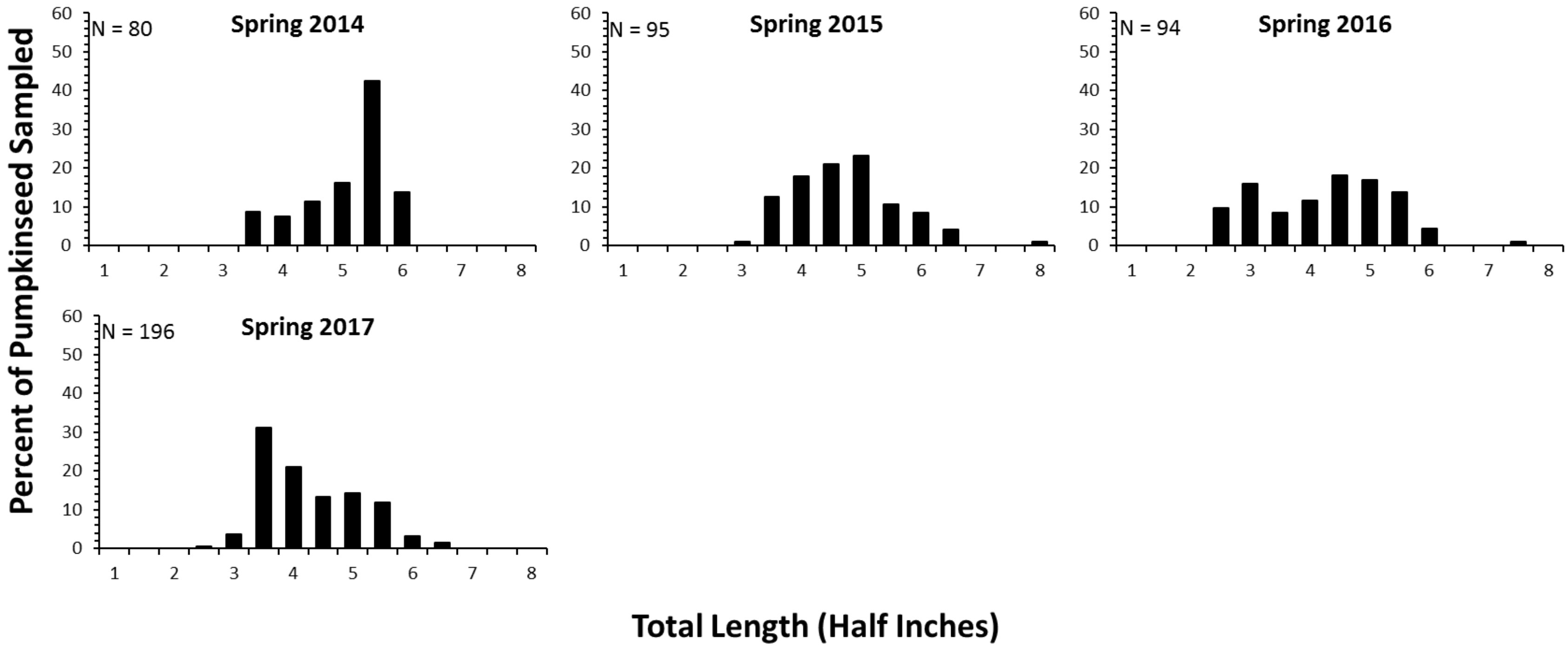

FIGURE 9 CONTINUED. Length frequency distributions for pumpkniseed sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of pumpkinseed measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

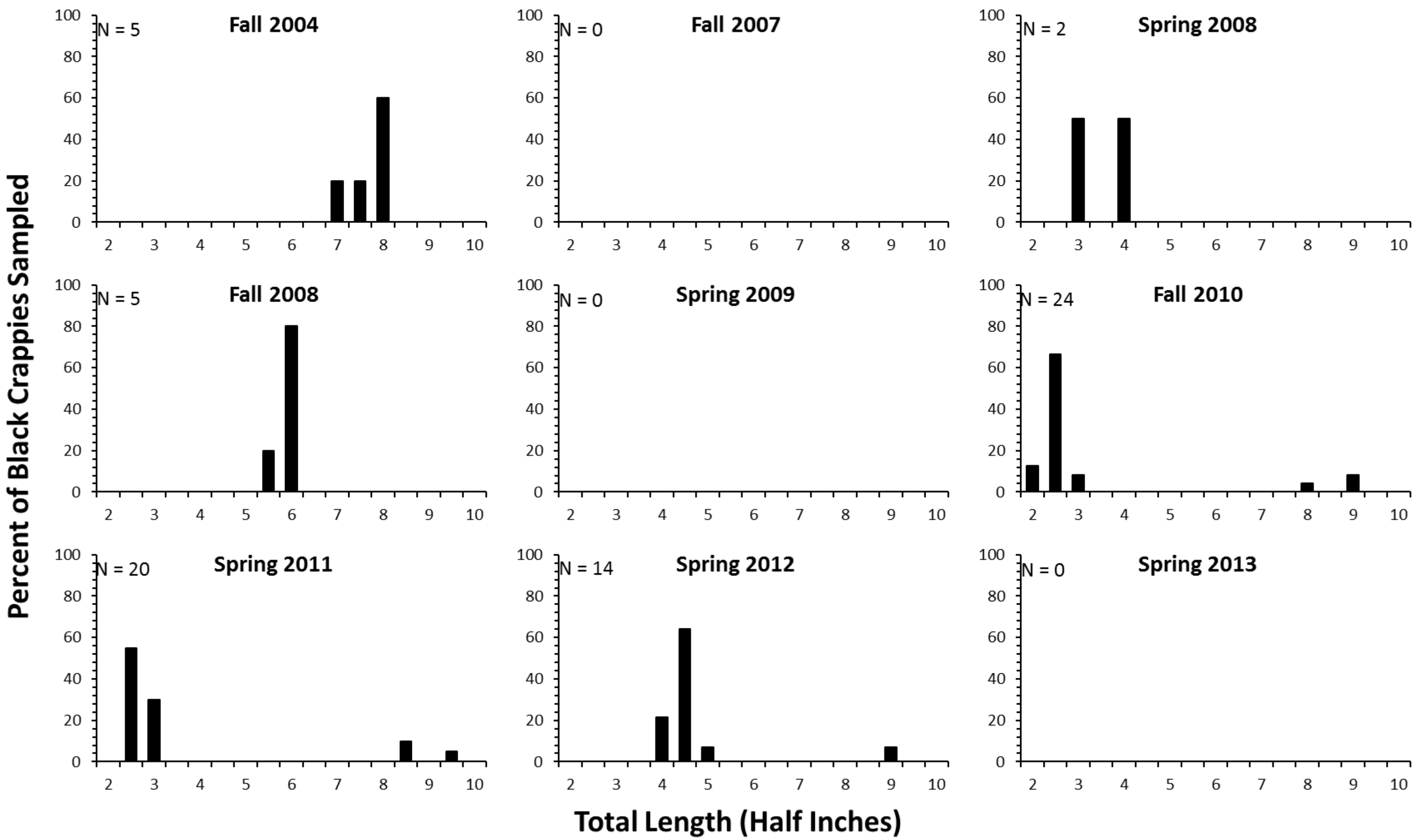

FIGURE 10. Length frequency distributions for black crappie sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of black crappie measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

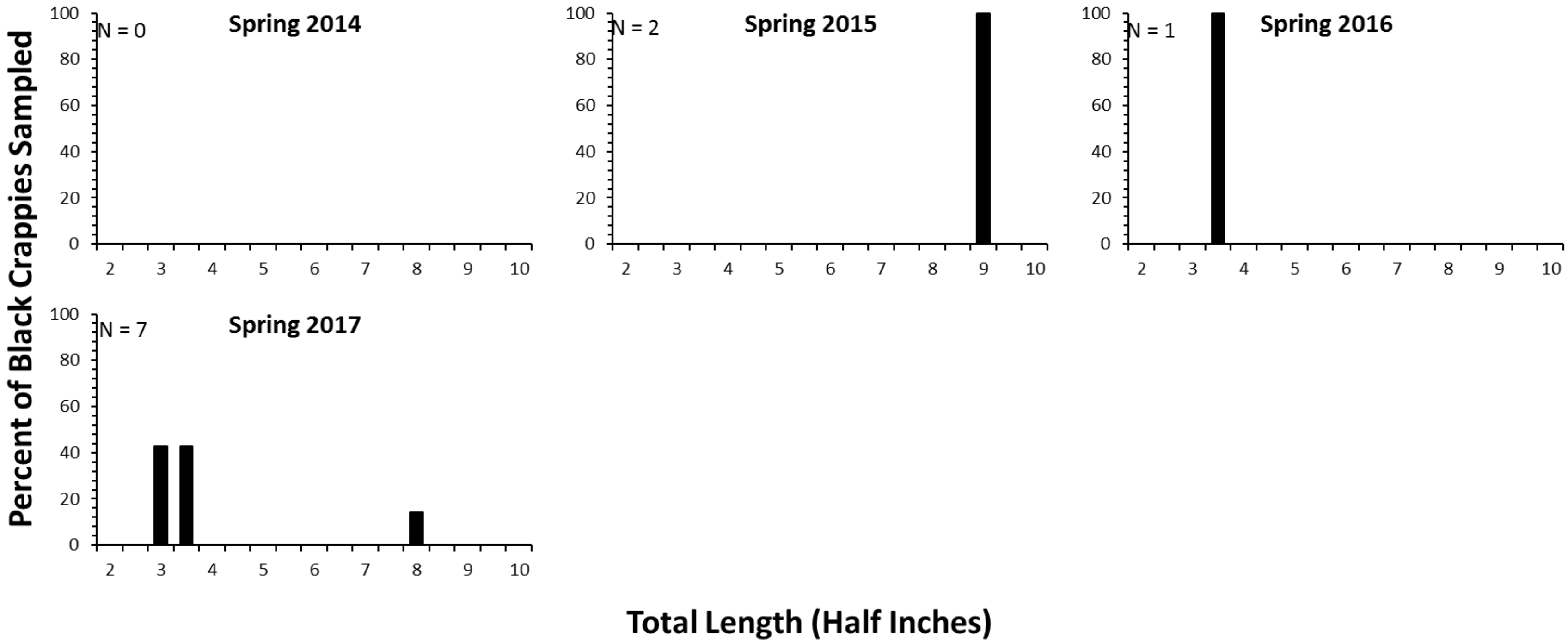

FIGURE 10 CONTINUED. Length frequency distributions for black crappie sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of black crappie measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

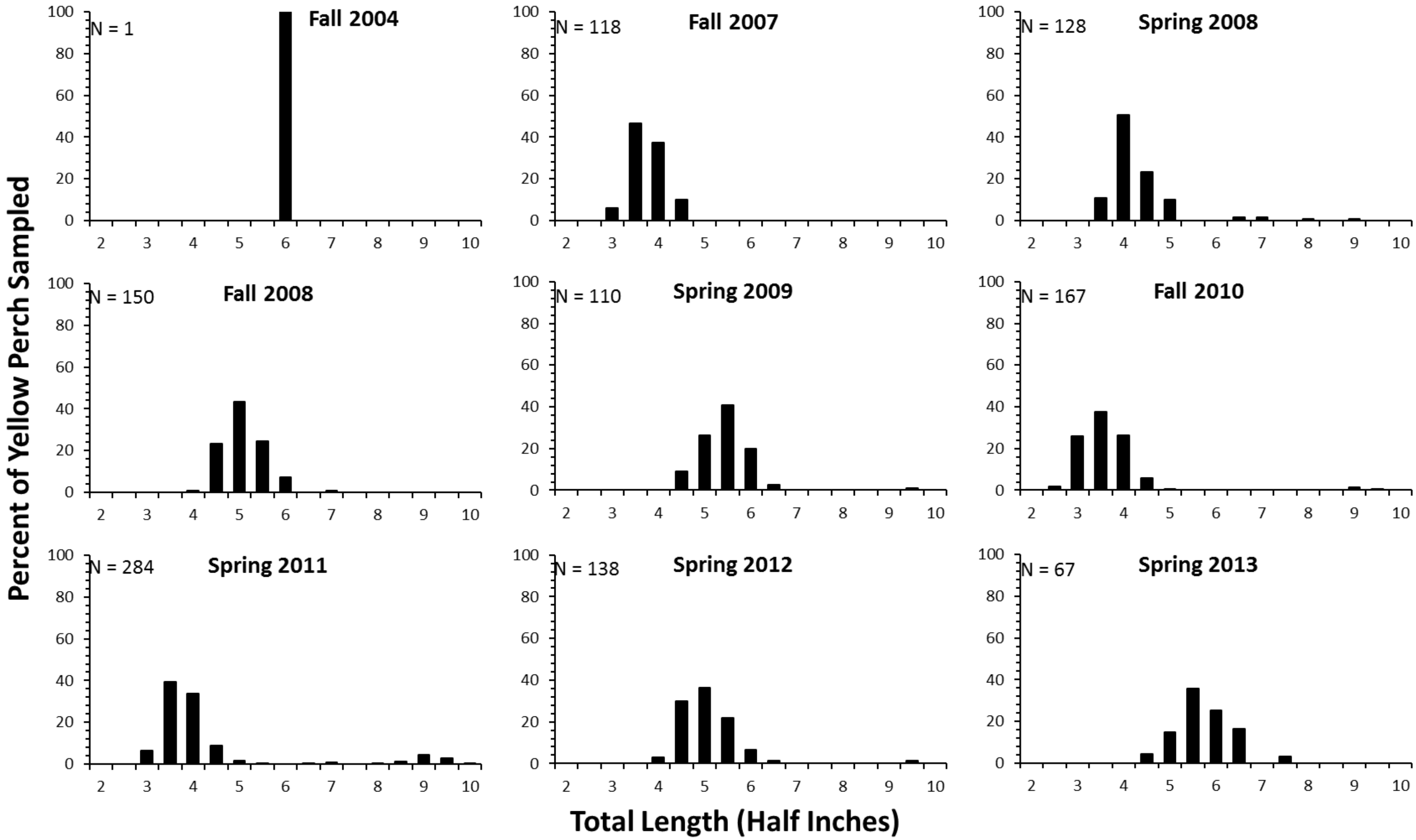

FIGURE 11. Length frequency distributions for yellow perch sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of yellow perch measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

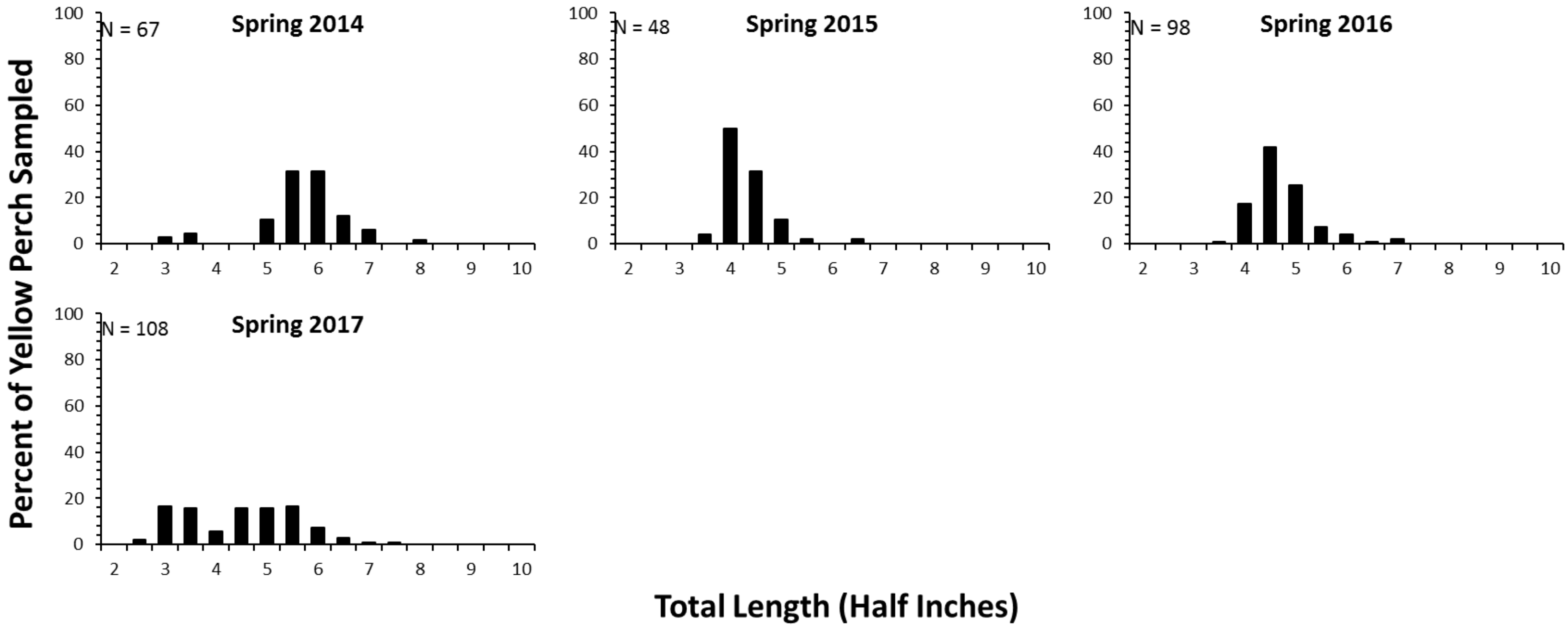

FIGURE 11 CONTINUED. Length frequency distributions for yellow perch sampled during electrofishing surveys of Marion Millpond, Waupaca County, Wisconsin between 2004 and 2017. Total number of yellow perch measured in each year are denoted on each graph by the letter N. Length distributions are presented as the percent of the total number measured for each half inch class.

Appendix: The following appendix contains maps of fyke net locations and electrofishing transects for all surveys described in the report.

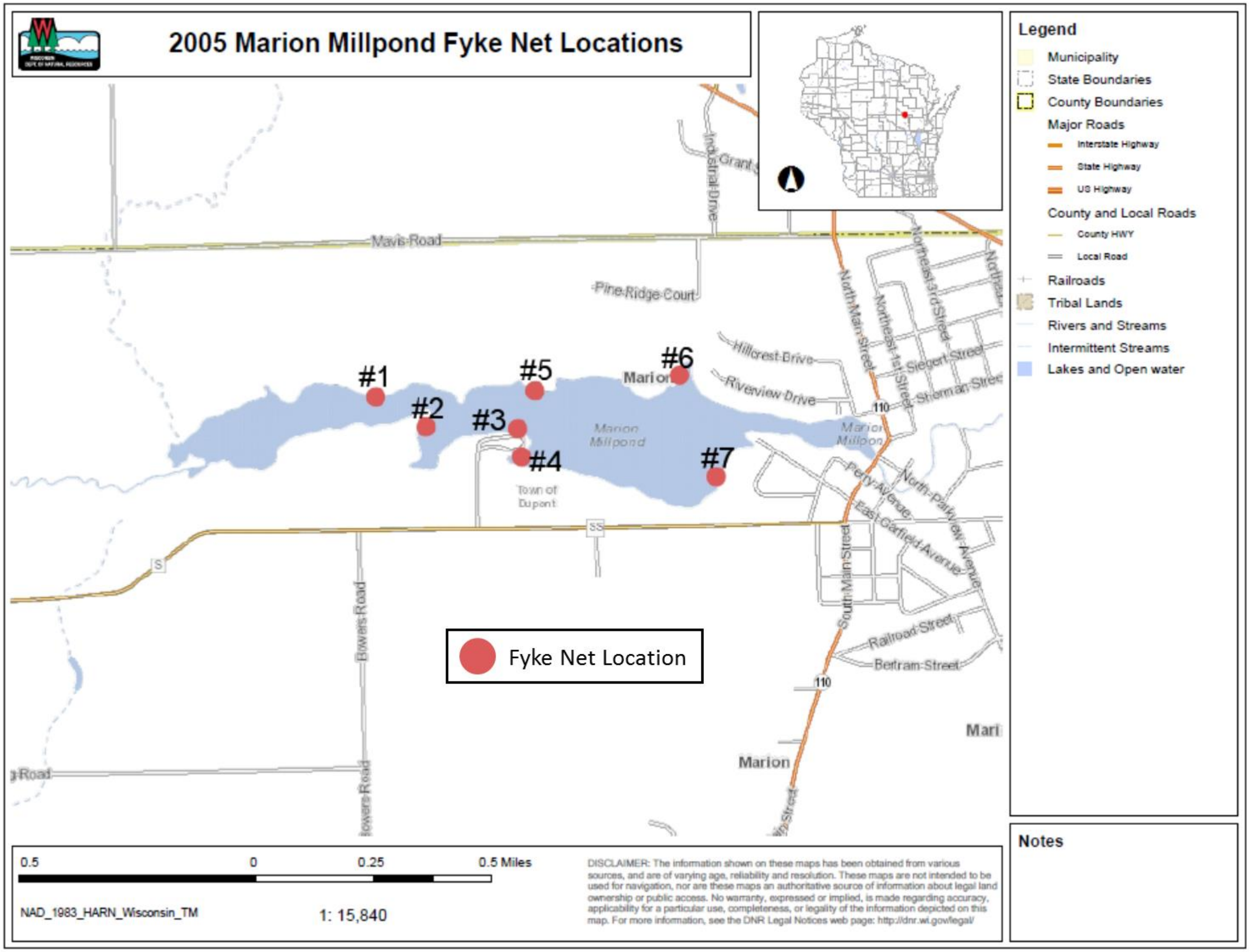

FIGURE 1A. Map of spring 2005 fyke net locations in Marion Millpond, Waupaca County, Wisconsin. Red circles represent net locations. Numbers represent the net number as referred to in the methods.

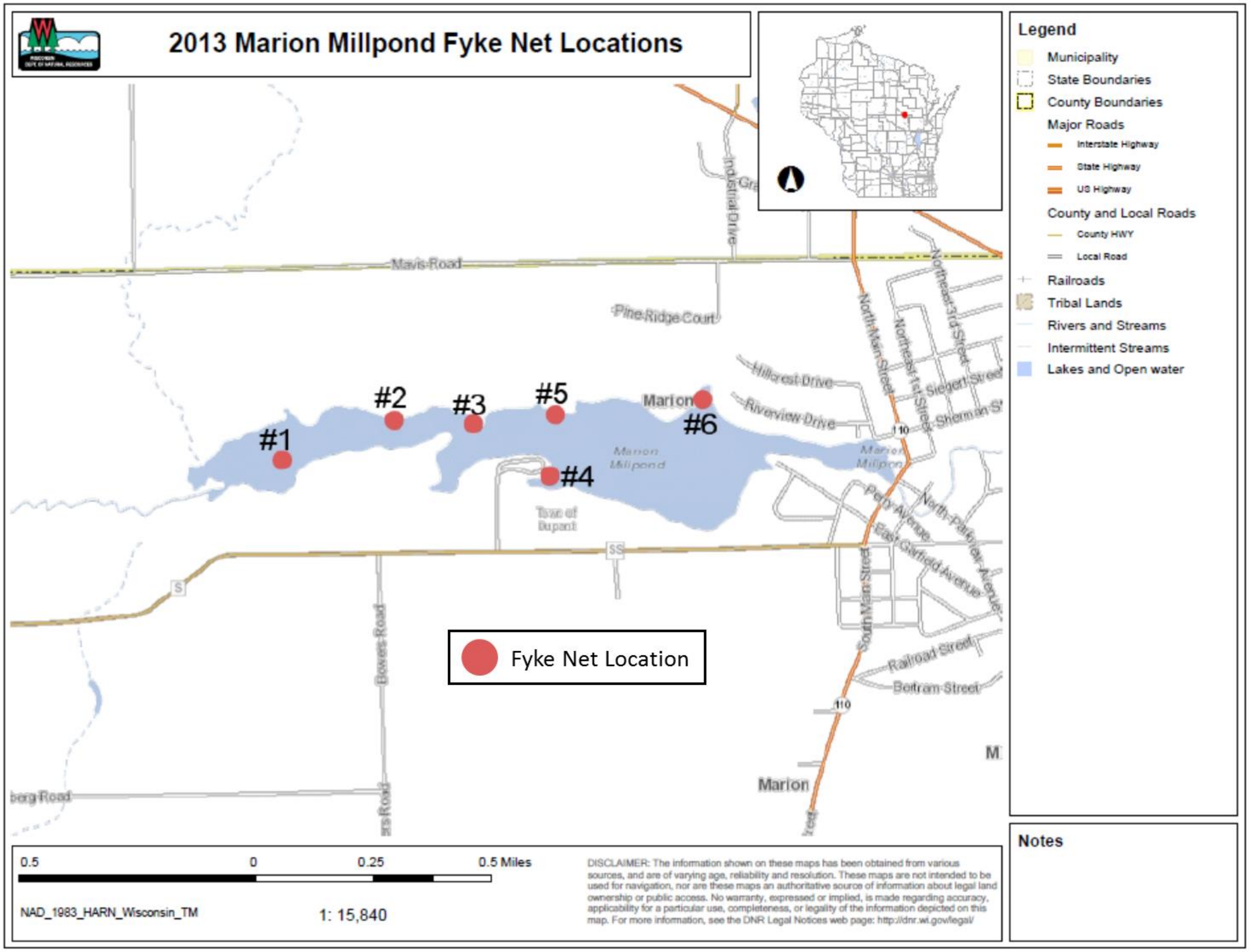

FIGURE 2A. Map of spring 2013 fyke net locations in Marion Millpond, Waupaca County, Wisconsin. Red circles represent net locations. Numbers represent the net number as referred to in the methods.

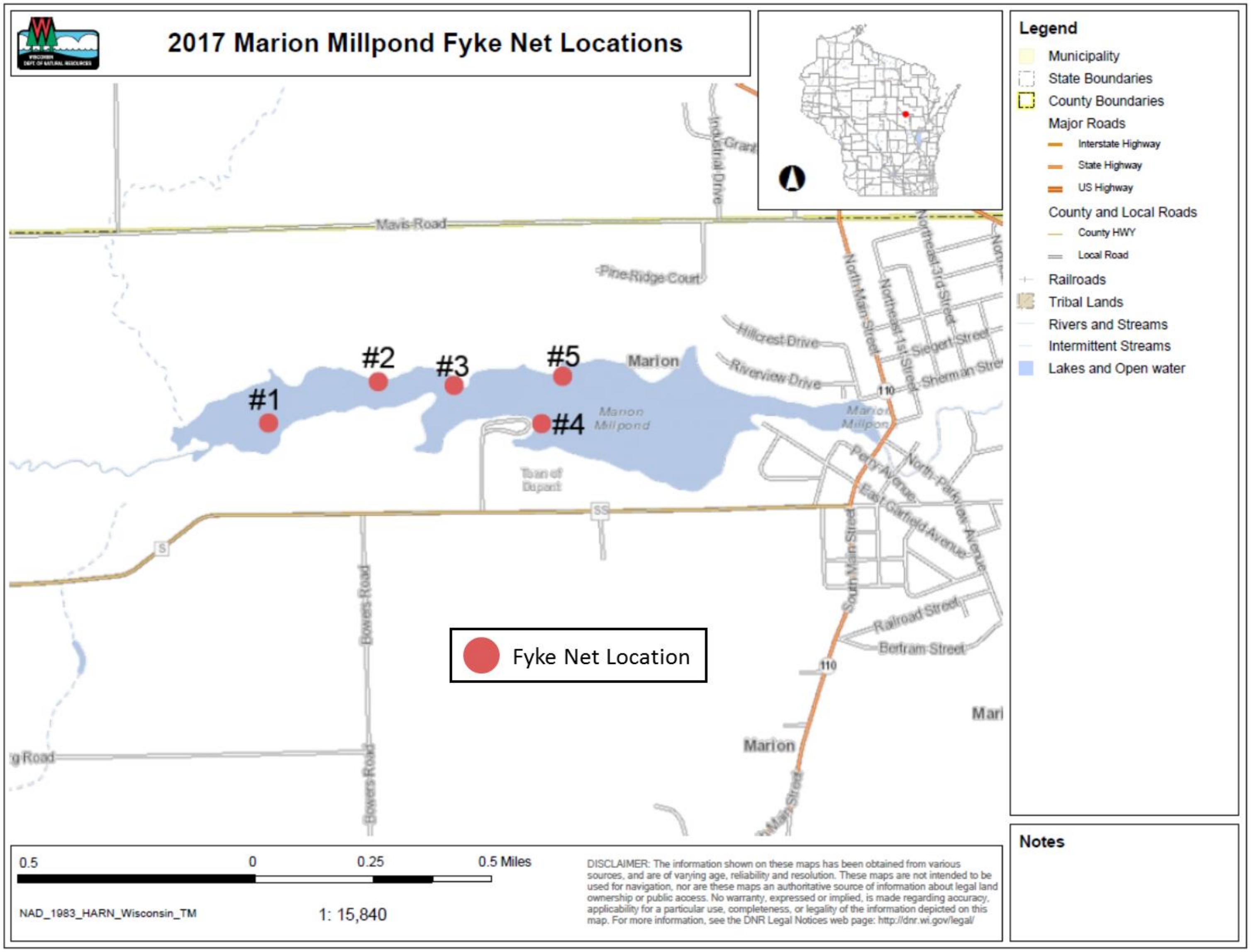

FIGURE 3A. Map of spring 2017 fyke net locations in Marion Millpond, Waupaca County, Wisconsin. Red circles represent net locations. Numbers represent the net number as referred to in the methods.

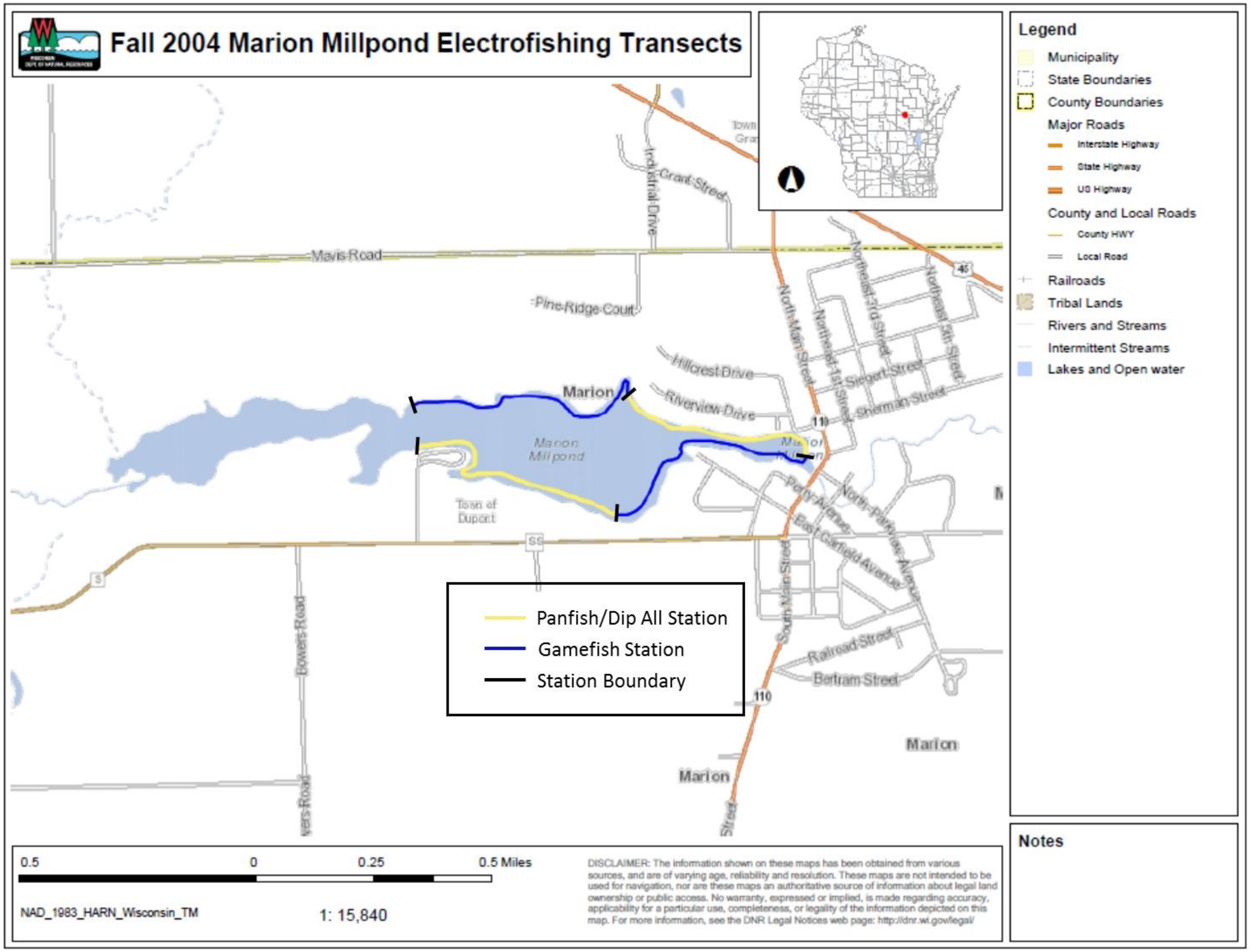

FIGURE 4A. Map of fall 2004 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Blue lines represent gamefish stations and yellow lines represent dip all stations. Black dashes represent station boundaries.

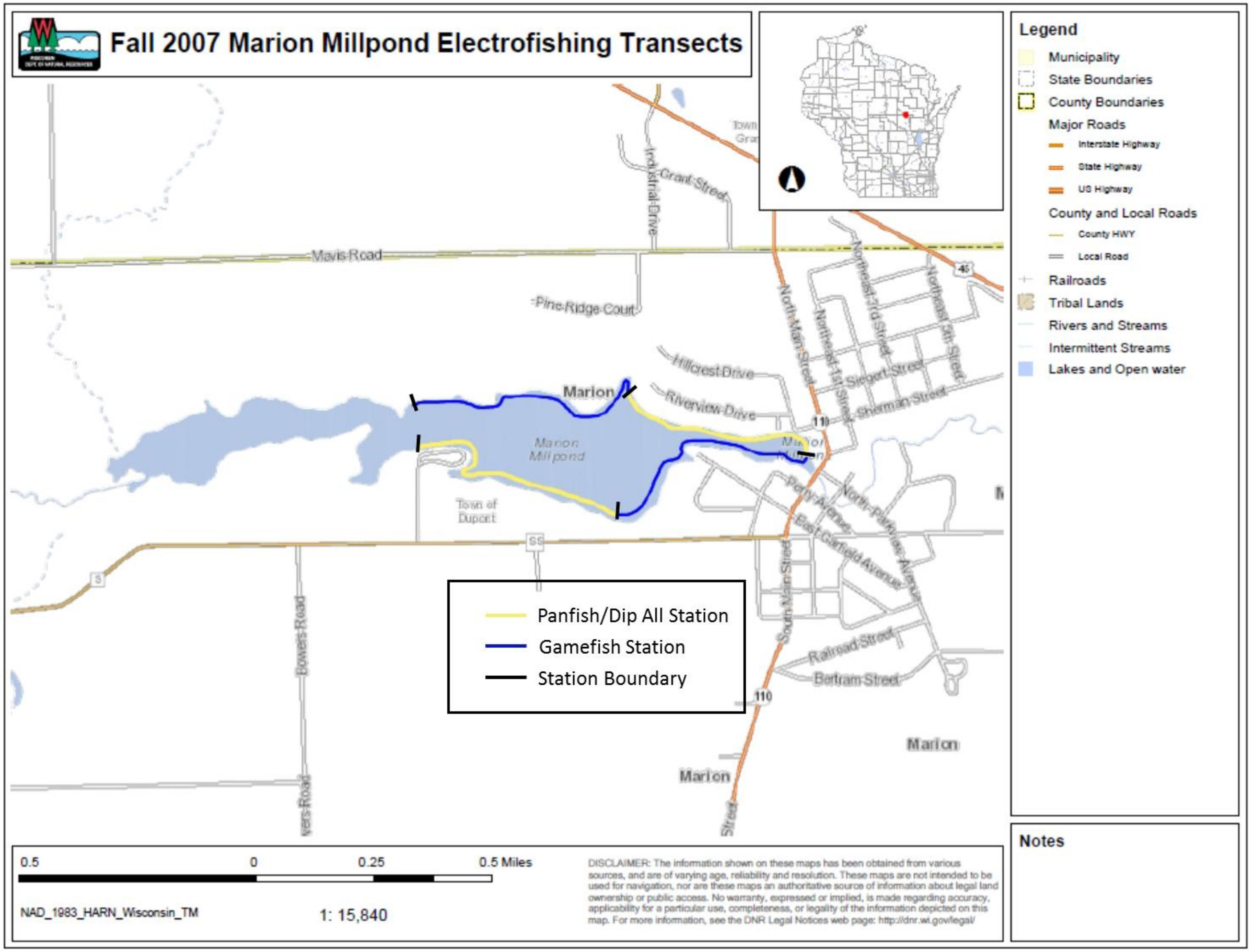

FIGURE 5A. Map of fall 2007 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Blue lines represent gamefish stations and yellow lines represent dip all stations. Black dashes represent station boundaries.

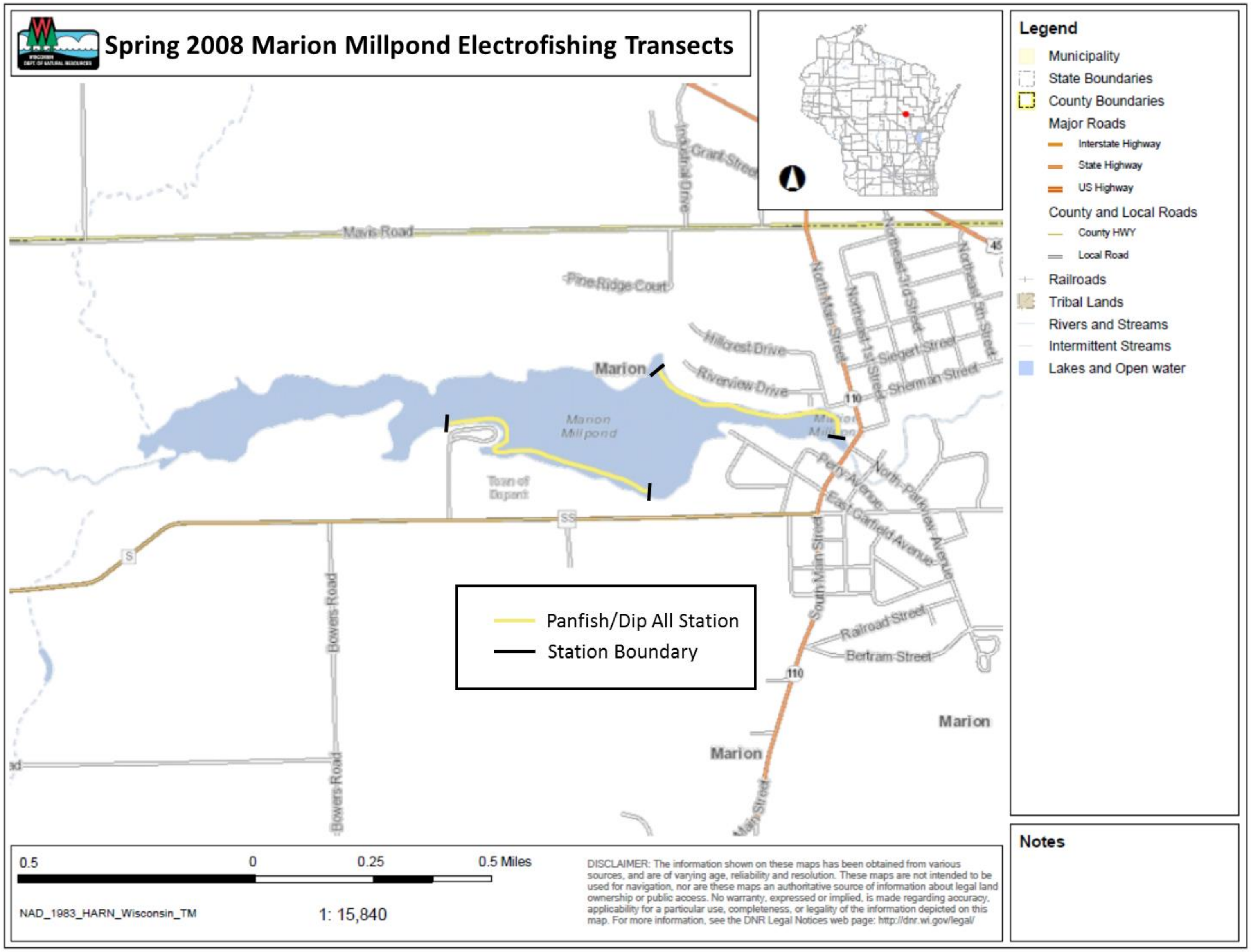

FIGURE 6A. Map of spring 2008 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

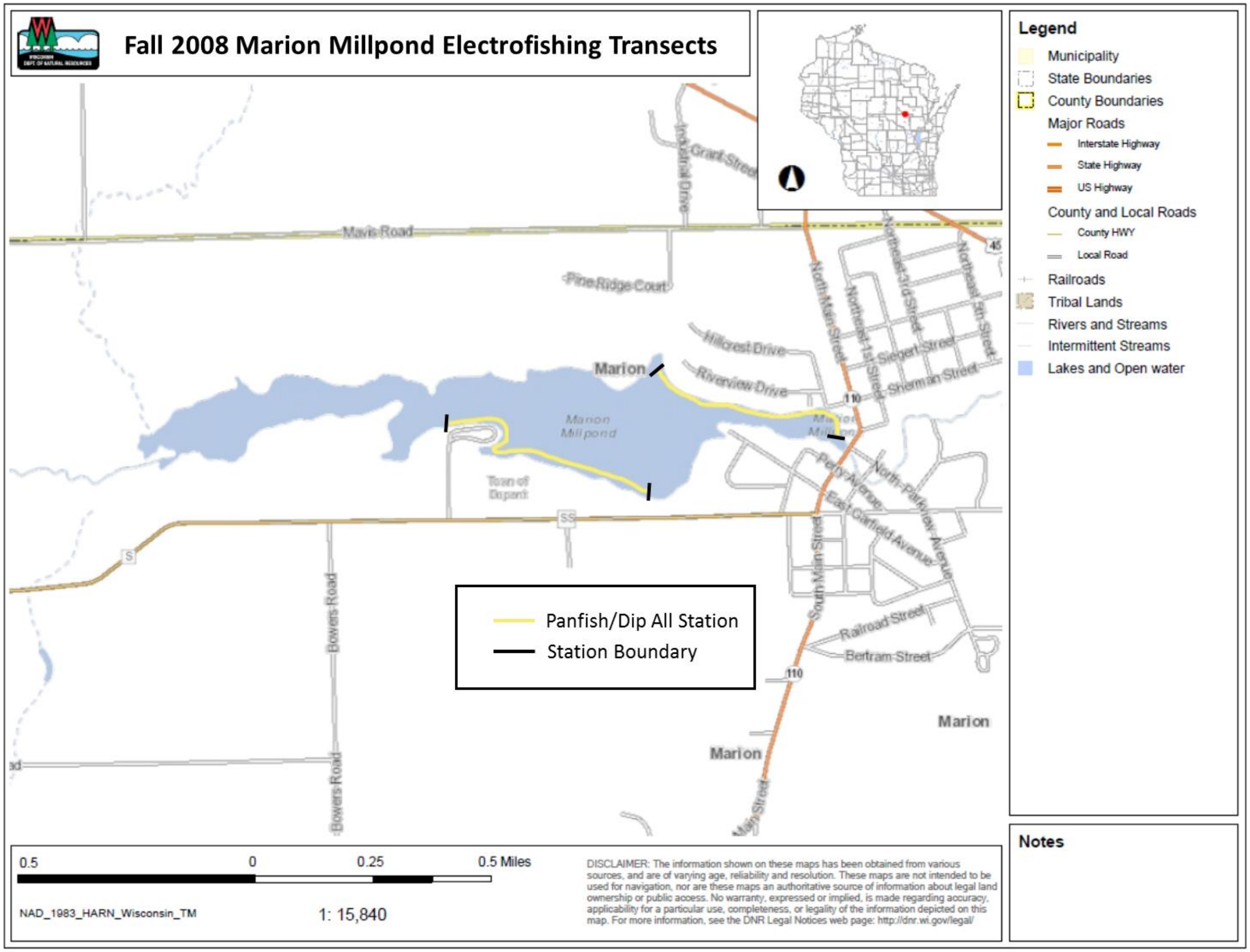

FIGURE 7A. Map of fall 2008 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

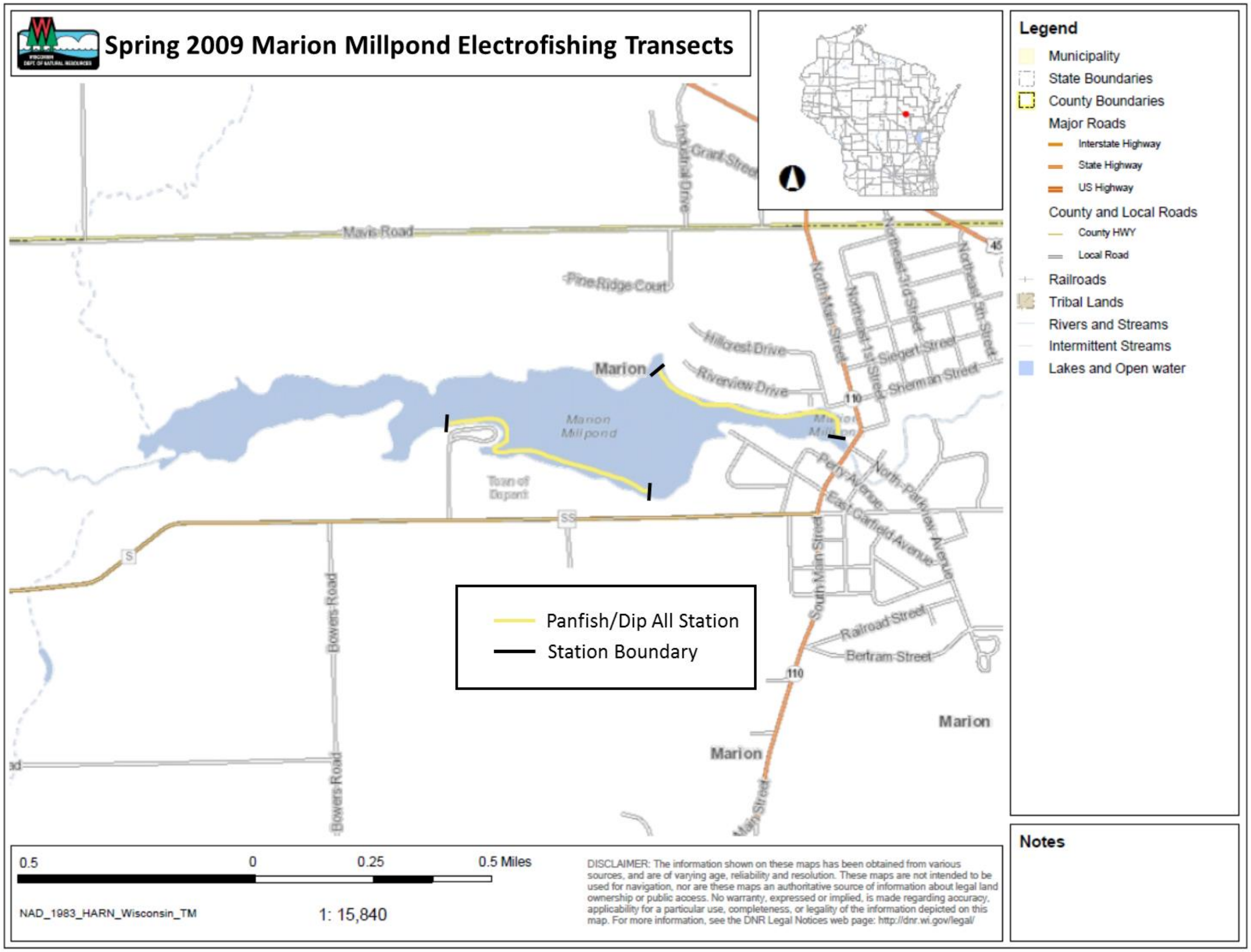

FIGURE 8A. Map of spring 2009 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

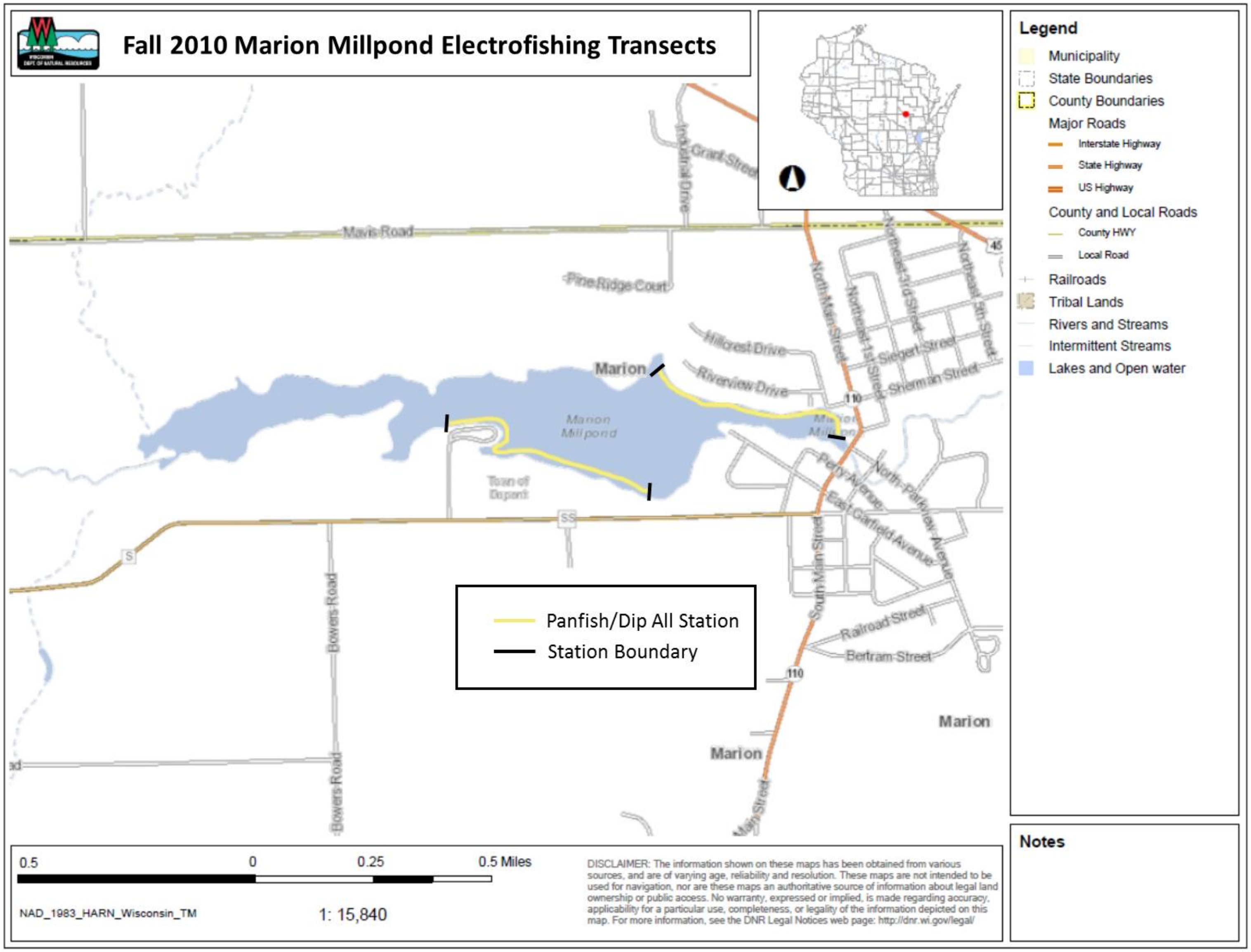

FIGURE 9A. Map of fall 2010 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

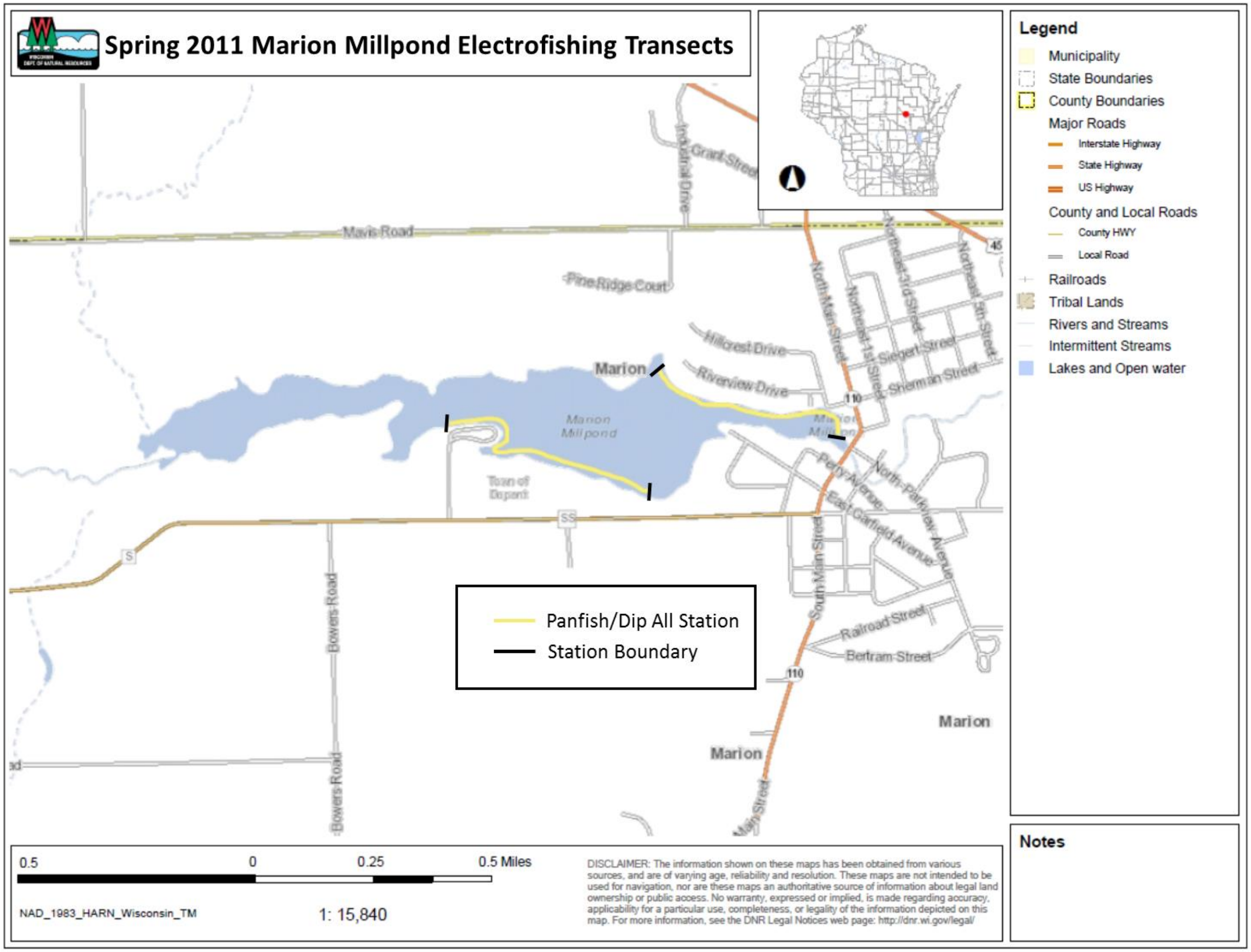

FIGURE 10A. Map of spring 2011 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

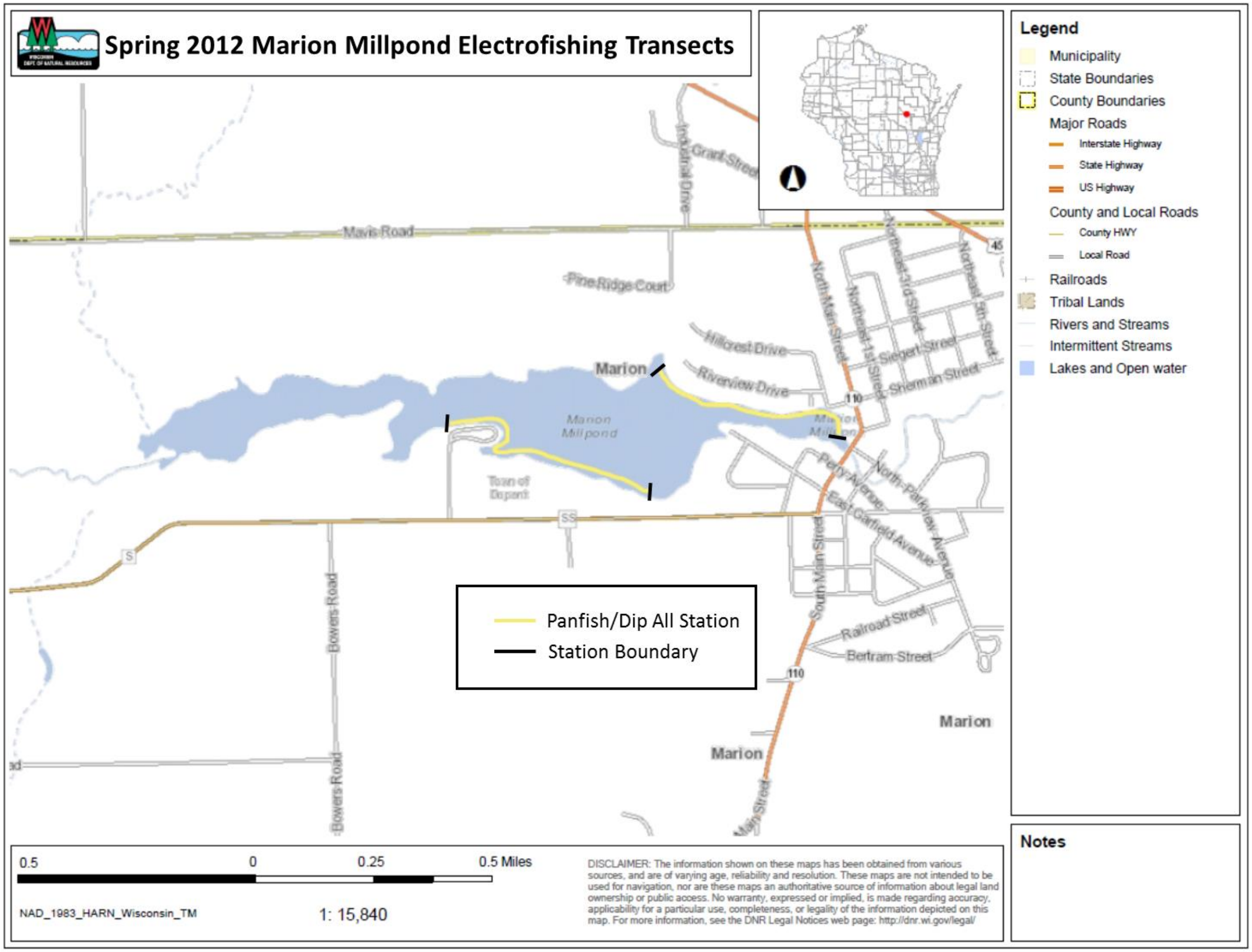

FIGURE 11A. Map of spring 2012 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

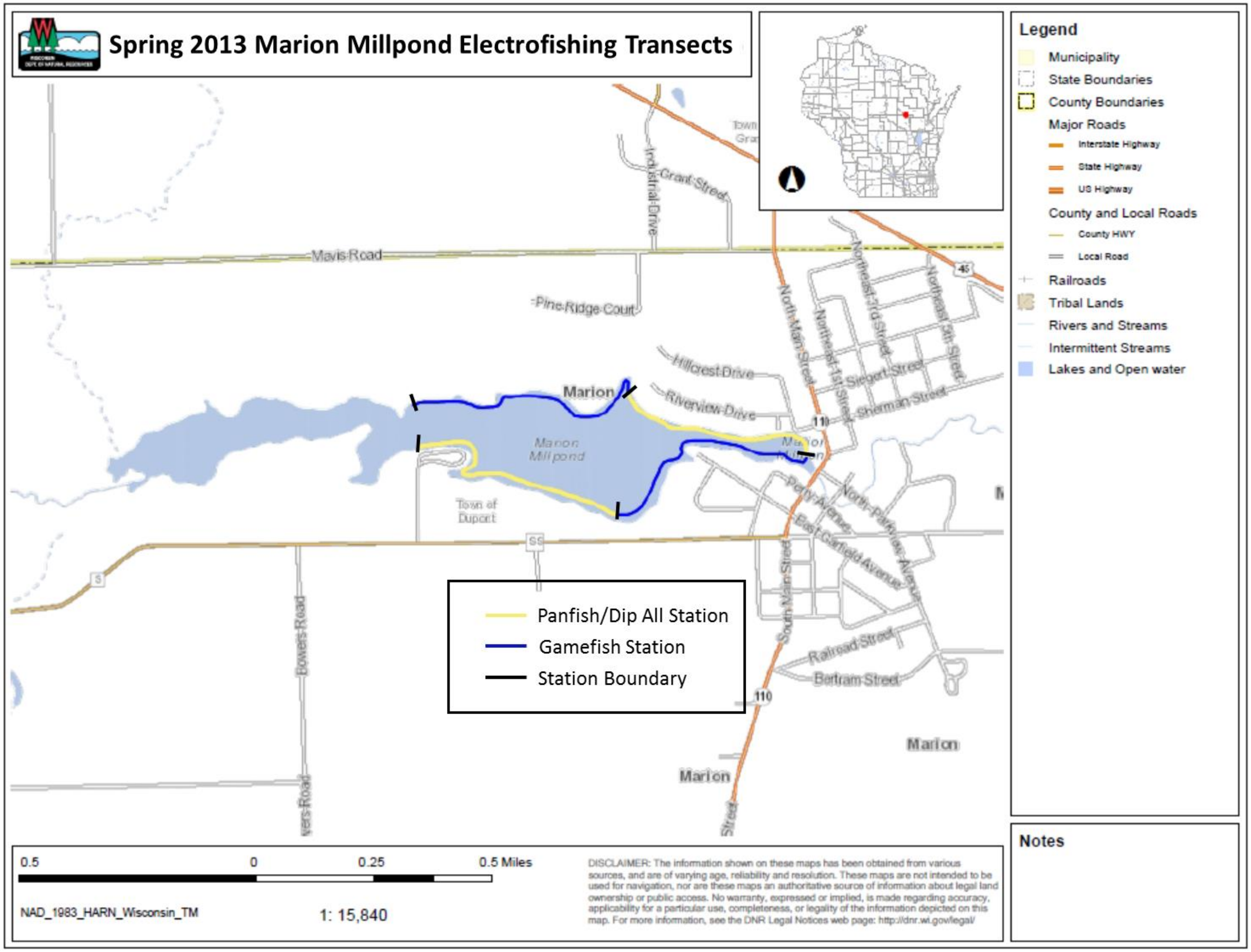

FIGURE 12A. Map of spring 2013 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Blue lines represent gamefish stations and yellow lines represent dip all stations. Black dashes represent station boundaries.

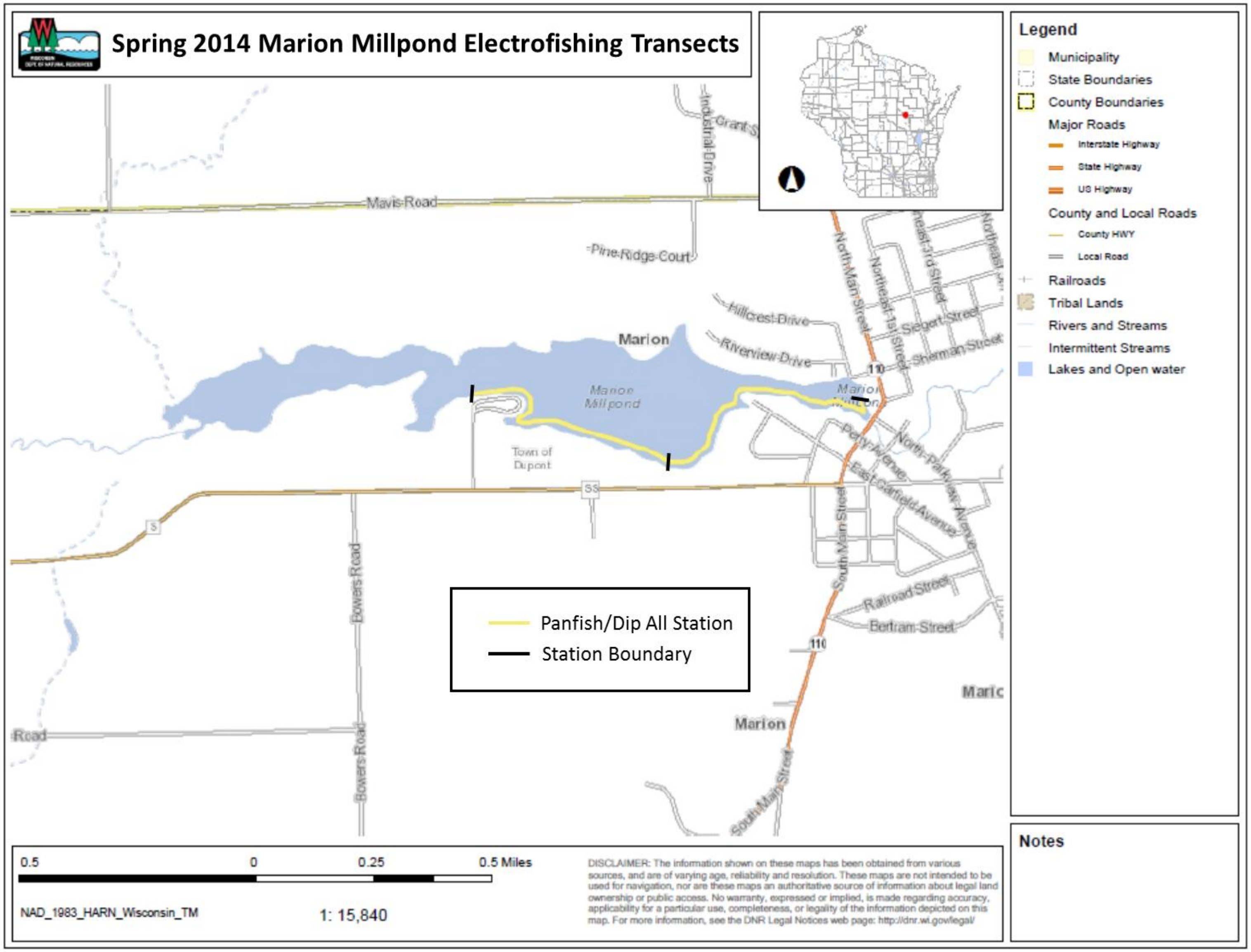

FIGURE 13A. Map of spring 2014 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

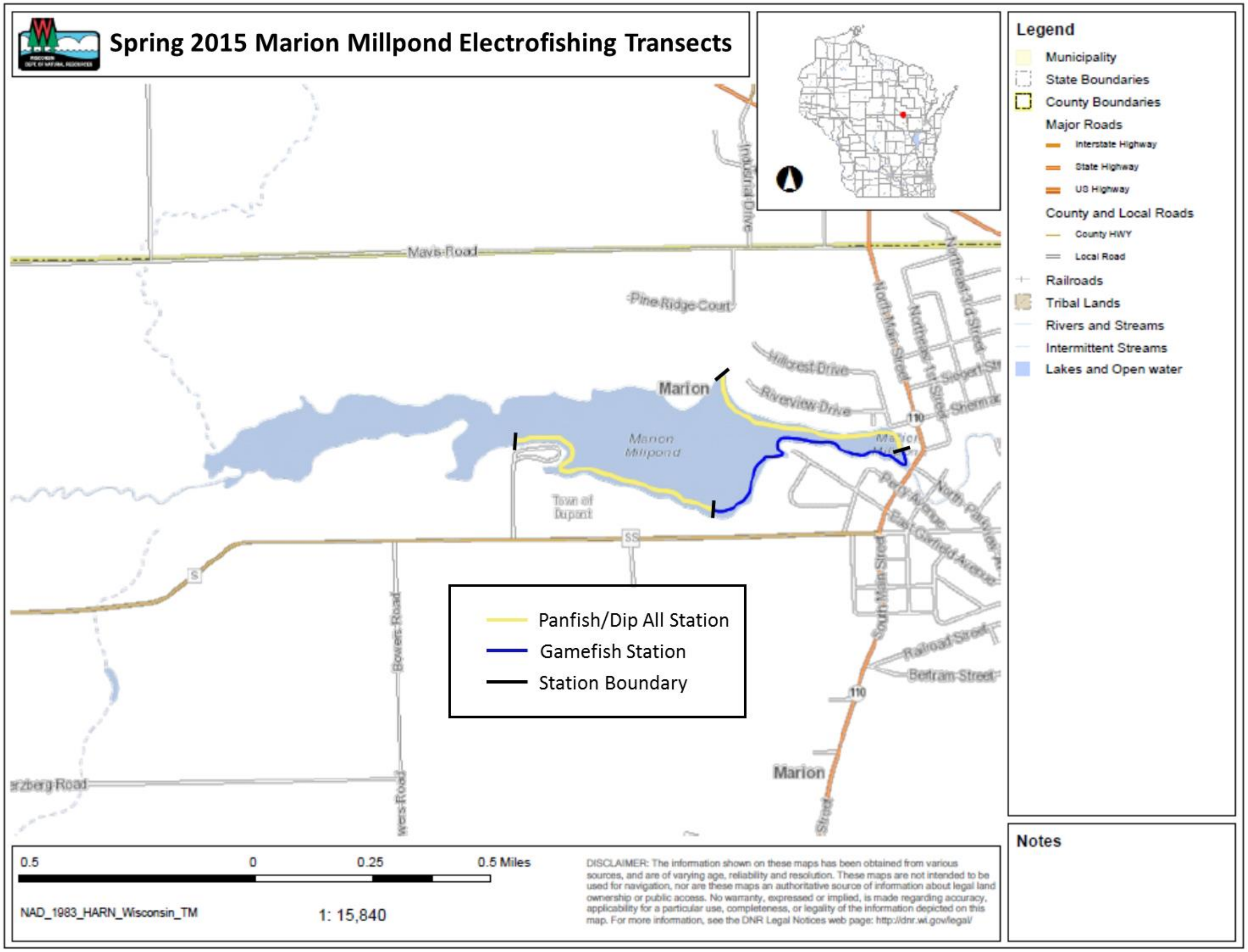

FIGURE 14A. Map of spring 2015 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Blue lines represent gamefish stations and yellow lines represent dip all stations. Black dashes represent station boundaries.

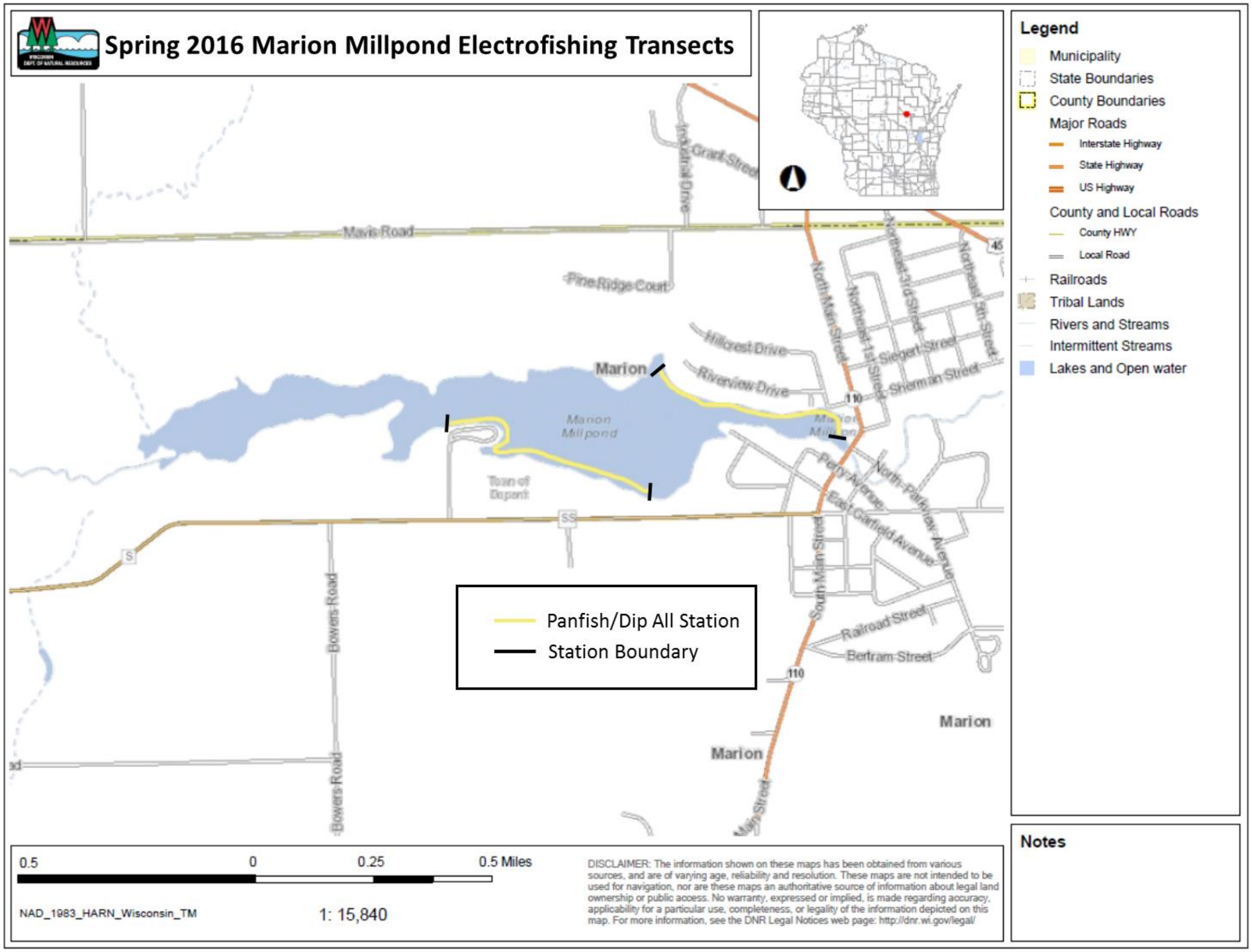

FIGURE 15A. Map of spring 2016 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.

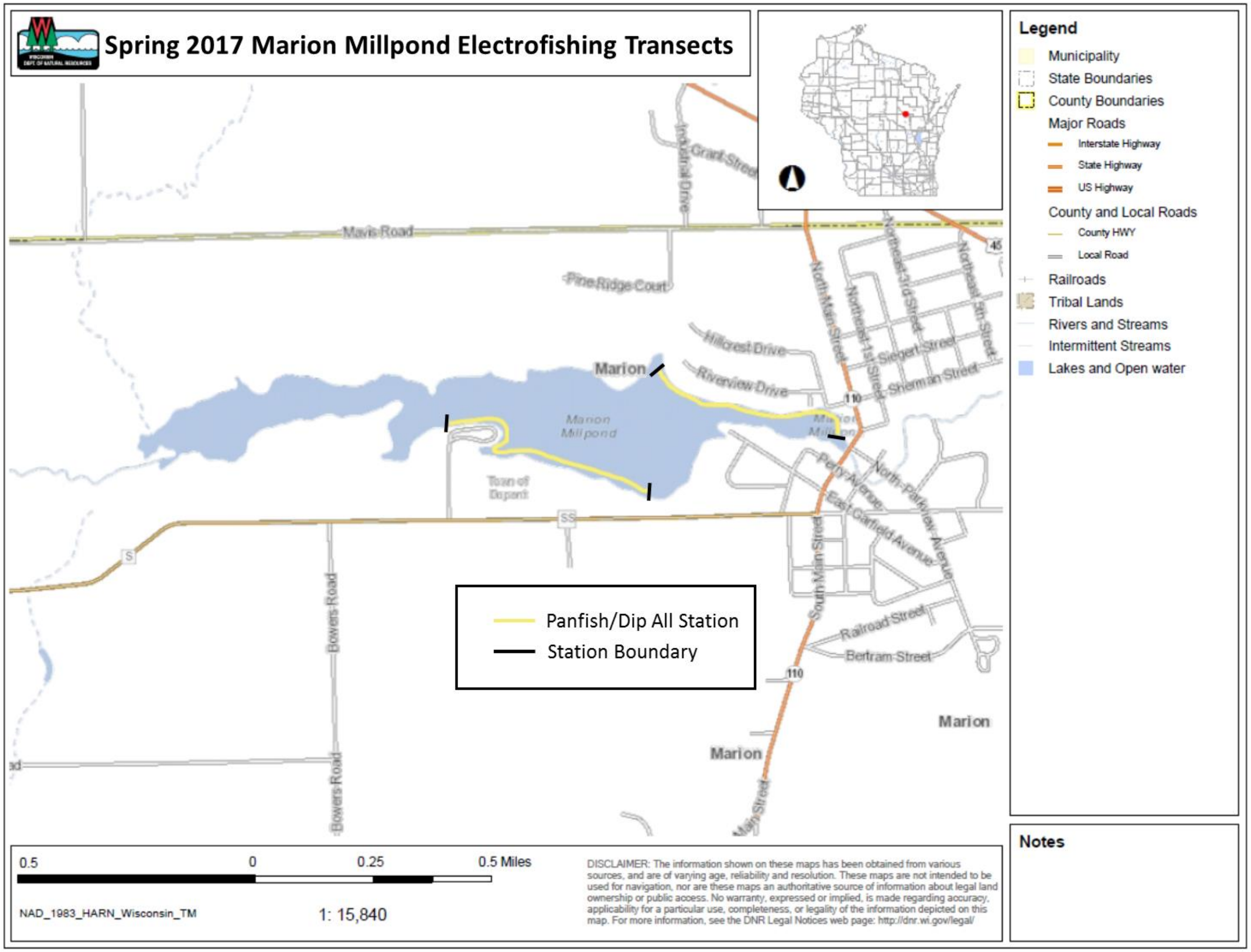

FIGURE 16A. Map of spring 2017 electrofishing station locations in Marion Millpond, Waupaca County, Wisconsin. Yellow lines represent dip all stations. Black dashes represent station boundaries.